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ORIGINAL ARTICLES

RESEARCH IN SPRING WIRES USING ORIGINAL METHODS AND TESTING APPARATUS*

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METALLURGY is an exceedingly dry subject to most people and I do not believe that the orthodontist is an exception, therefore, I will try to deal with my subject only in its phases of interest and importance to you.

Firstly I am greatly indebted to the assistance of Dr. Walter H. Ellis, on whose instigation I started this work. He was the final authority on any new alloys or wires that I brought out. His application was the actual and practical and his suggestions and assistance were of the utmost value. I also wish to thank Dr. Herbert A. Pullen and Dr. Abram Hoffman for the assistance that they seemed only too glad to give. It was a great pleasure to work with all of these gentlemen.

I wish to mention others to whom I am indebted for much valuable information.

Dr. David E. Waite, Professor of Metallurgy, the University of Buffalo, formerly of the Massachusetts Institute of Technology and American Steel and Wire Co.

Mr. W. H. Bassett, Technical Supt. of the American Brass Co.

Mr. W. H. Blocksedge, Chemist and Metallurgist of the J. H. Williams Co.

Prof. E. M. Chamot, of the Department of Chemistry, Cornell University.

The need for a greater knowledge of wires in dentistry was brought to my attention several years ago in a rather forceful manner. In fact, the following incident made me firmly resolve that if I ever had any spare time in the future, I would devote it to research on this subject.

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A certain nationally known dentist was giving clinics on wire clasp construction. The course was popular and there were a great many dentists, also several commercial laboratory men enrolled in the course. Owing to the great demand for wire, the supply at the dental depot soon ran out and the course was temporarily paralyzed. Although the supply house did not have the wire, they had the same metal in the form of casting ingots. This led to the happy solution. They would invest the standard eighteen-gauge sprue and cast the wire. I entered the scene just at the time that they were washing the plaster out of the mold in which the wire had been cast. I frankly believe that the majority present thought that now they had the wire and the clinic could go merrily on. Of course the wire was a failure. It had neither the necessary strength nor springiness.

In dental metallurgy, we use the following terms when speaking of the physical properties of wire—"elasticity"—"strength"—"color"—and "susceptibility to oxidation."

A definition of "elasticity" is as follows,—it is that property of ability to recover to an original size or shape.

"Springiness" is defined as the state or quality of being "springy," for example, elasticity as of a spring.

A spring is defined as an elastic structure, body or contrivance that yields under stress and returns to its normal form when the stress is removed.

Going back to the definition of elasticity as being the property of matter by virtue of which a body tends to return to its normal size, shape or altitude, after being deflected, compressed, expanded, twisted or drawn, it is further defined as being the rebounding quality of bodies, resilience, springiness.

In other words, the terms elasticity and springiness are absolutely synonymous, by the words of the dictionary and by the manufacturing field in general. I believe that dental manufacturers would create less confusion if they manufactured wires known by their different degrees of springiness instead of manufacturing an "elastic" wire and a "spring" wire. I believe that I am correct in presuming that these "elastic" wires are less "elastic" than the "spring" wires. No substance can be springy without possessing elasticity, so in my paper and charts, I will use these terms quite properly interchangeably.

A watch spring may be coiled and uncoiled many millions of times a year without impairing its elasticity, yet this spring may have its shape permanently altered by subjecting it to a force greater than in the motion of a watch. The incompleteness of recovery from the effects of a great force is as important a fact as the completeness of recovery from comparatively small forces. I wish to lay special stress on this point, inasmuch as it forms the basis of what I consider my most important testing machine. This instrument can quickly demonstrate "perfect elasticity" as well as "imperfect or incomplete elasticity." It can also show the limitations which must be placed upon forces in order that the elasticity be perfect.

A body which undergoes change of shape or size is said to be strained. The problem of extension of a bar under tension is the one that has been most studied experimentally. It has been found that in all metal, except cast metal,

the extension is proportional to the tension, provided this tension is not too great. This result takes the form of a law first brought out by Robert Hooke in 1678. "The power of any spring is in the same proportion as the tension thereof."

Steel piano wire is perfectly elastic within rather large limits, glass is also perfectly elastic but within small limits. When the limit of elasticity is not exceeded, no injury is done to a material by the action of forces.

The occasional non-uniformity and undependability of dental spring wires is a matter of common knowledge. The firm of which I have the most knowledge, has received more complaints on wires than on all of its other products combined. The overhead of that department is greater, its profit smaller and its output, in dollars, smaller than any other department. To manufacture proper wire, there must be pyrometer control of heats, swaging machines with roller and die replacements, draw benches equipped with genuine diamond dies through which to draw the wire in order that it be exact in size. Also, there are required special annealing furnaces and physical testing instruments to

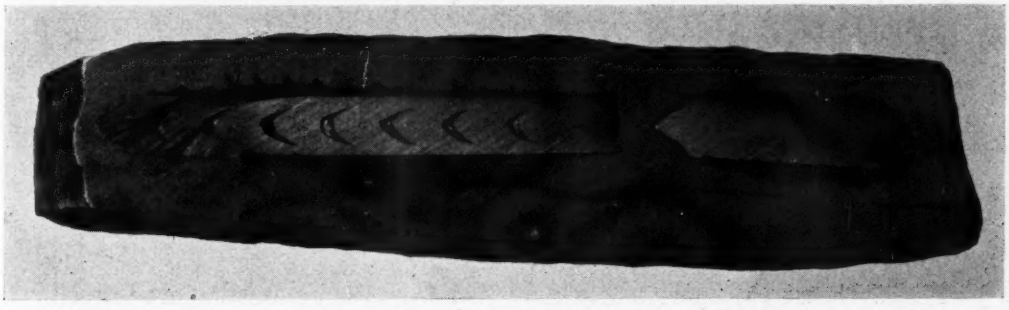


Fig. 1.—Twelve gauge defective spring wire imbedded in block of lead showing the two ends of wire at the point of fracture. The surface has been ground away exposing the interior "cuppy formation." The "arrow-heads" or "cups" indicate the direction of cold-working. Magnified five diameters.

determine if the wire is of the proper standard. There are drawn, and each has its own peculiarities, dozens of different alloys. The field is not large, yet the troubles are many and varied. I believe that it would not be out of place to show you the difficulties that are met with and the means we have of overcoming them. I will try to take up these difficulties in the order of their importance.

I don't mean to infer that all plants use these methods in their routine work, but their research work at least, must be along these general lines.

In referring to the physical properties of wire, I am going to use principally the following abbreviated terms, namely "tensile" and "torsion." Tensile refers to its tensile strength, and torsion to its ability to be bent. In orthodontia wires, you require both of these properties.

One of the most interesting defects, one that also occurs in the general wire manufacturing field, is known as "cuppy" wire. By "cuppy" wire, we mean wire which when fractured, one end takes the form of a cone and the other end a cup. When the ends are placed together the cone fits perfectly into

the cup. Notwithstanding a perfect appearing outer surface, the wire possesses neither good "tensile" nor "torsion."

Fig. 1 illustrates a longitudinal section of "cuppy" wire. It is imbedded in lead to facilitate preparation. You will note the interior cone formation. The outer surface appears perfect. No doubt there are gentlemen present who have received wire showing this same fracture. It was only after considerable research that we ran down the conditions that led to this defective wire. It was due, firstly, to segregation of metal and secondly, to "overdraft."

In respect to segregation of metal, platinum, iridium and nickel seem to be the worst offenders. By segregation I mean the partial separation of the constituents of an alloy in such a way as to render the alloy non-uniform in composition.

Fig. 2 shows segregation in a transverse or cross section of wire. The alloy contains a total of 21 per cent platinum and palladium. The white material shows platinum segregation. This casting was partially worked. An expert with the microscope could tell that this metal has been worked. Subsequent slides will illustrate why.

Needless to say, this casting went back into the crucible.

Fig. 3 is the same melt recast and slightly worked. The segregation is not so pronounced but it is still extremely bad. It went back again into the crucible.

Fig. 4 is the third metal and finally a good one. You will note the general uniform distribution of platinum, also the peculiar lattice work structure. This is known as dendritic formation and is a typical casting structure. The metal has been unworked.

Fig. 5 shows the same metal annealed for two hours at a dull red heat. The casting structure has been removed. You will again note the uniform distribution of platinum. If this ingot is properly swaged and drawn, the resulting wire must be good.

Fig. 6 shows the second casting of a 6 per cent platinum alloy, that was drawn into eighteen-gauge wire. The wire tested up fairly well and passed inspection. You will note, however, that there is still decided segregation.

Fig. 7 is a longitudinal view of the same wire. It shows a typical wire structure and of course, the segregation. This wire has been annealed to cherry red, yet the condensed crystalline structure has not disappeared. I believe that on annealing over a period of hours, this would occur.

Fig. 8 is the first cast of an 18 per cent platinum alloy. If they all came out like this, our troubles would end. The platinum distribution is very uniform.

Fig. 9 is a close up of the same metal. Considering a magnification of five hundred times, it is exceptionally homogeneous. This slide is interesting because it shows the platinum grain boundaries.

Fig. 10 shows the method of digging out the segregated spots to determine by chemical analysis what the metal might be. In this particular instance, as we had suspected, an analysis of this area proved that it had a preponderance of platinum over the original alloy.

Fig. 2.—Platinum segregation in a 21 per cent platinum palladium alloy, also shows blow-holes. Transverse view magnified one hundred twenty-five diameters.

Fig. 3.—Recast of same metal shown in Fig. 2. Platinum segregation still pronounced. Blow-holes smaller in size and number. Transverse view magnified one hundred twenty-five diameters.

Fig. 4.—Third melt of metal shown in Figs. 2 and 3. Shows typical casting, unannealed and unworked structure. Platinum distribution very uniform. No segregation. No blow-holes. Transverse view magnified one hundred twenty-five diameters.

Fig. 5.—Same metal as shown in Fig. 4 after annealing for two hours at a dull red heat. The casting structure has been removed. Transverse view magnified one hundred twenty-five diameters.

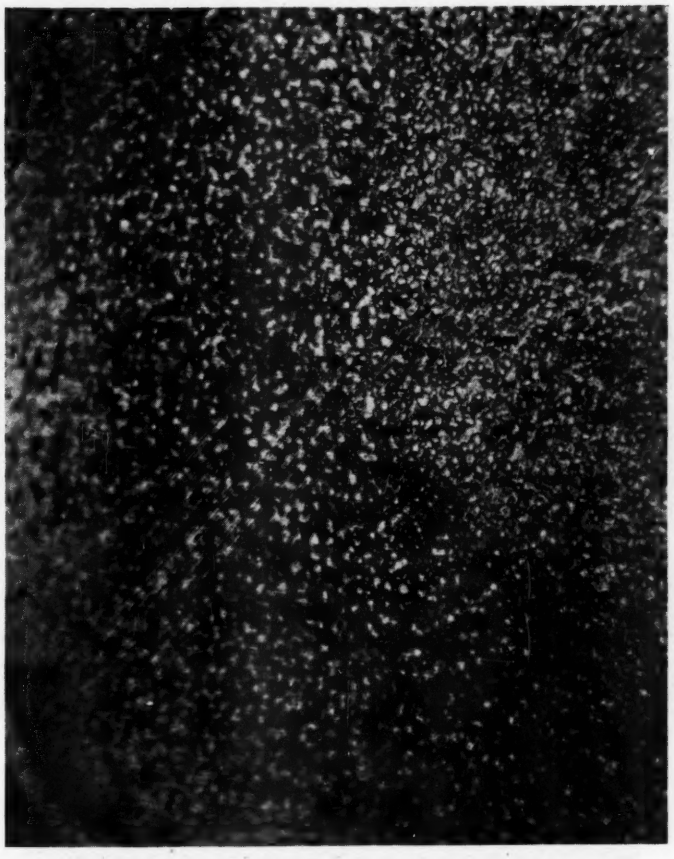


Fig. 6.—Wire from a second cast of a 6 per cent platinum alloy. Shows marked segregation. No blow-holes. The wire tested fairly well. Transverse view magnified one hundred twenty-five diameters.

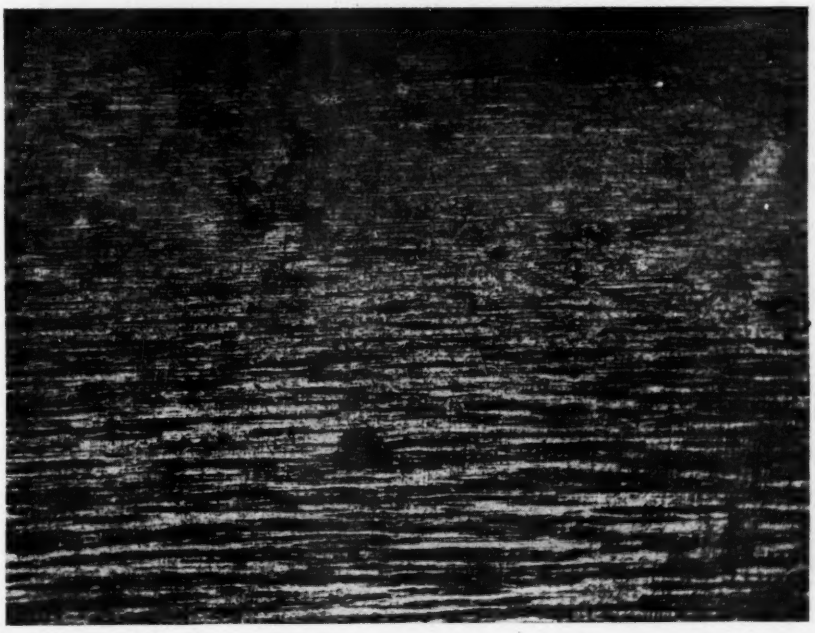


Fig. 7.—Same metal as Fig. 6. Shows typical wire or cold worked structure, also segregation as observed in the transverse view of Fig. 6. Longitudinal view magnified one hundred twenty-five diameters.

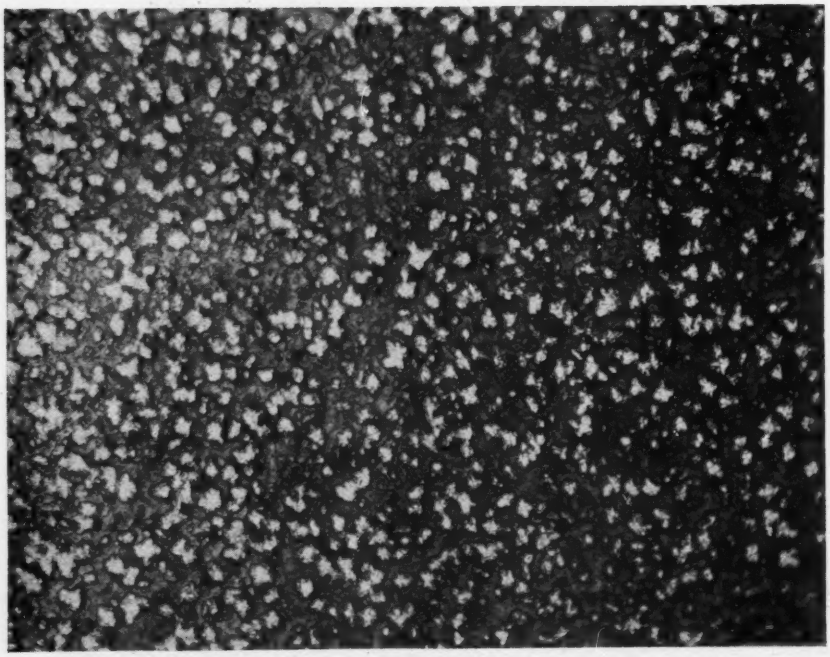


Fig. 8.—First cast 18 per cent platinum alloy. No blow-holes. No segregation. The metal has been annealed but not worked. Transverse view magnified one hundred twenty-five diameters.

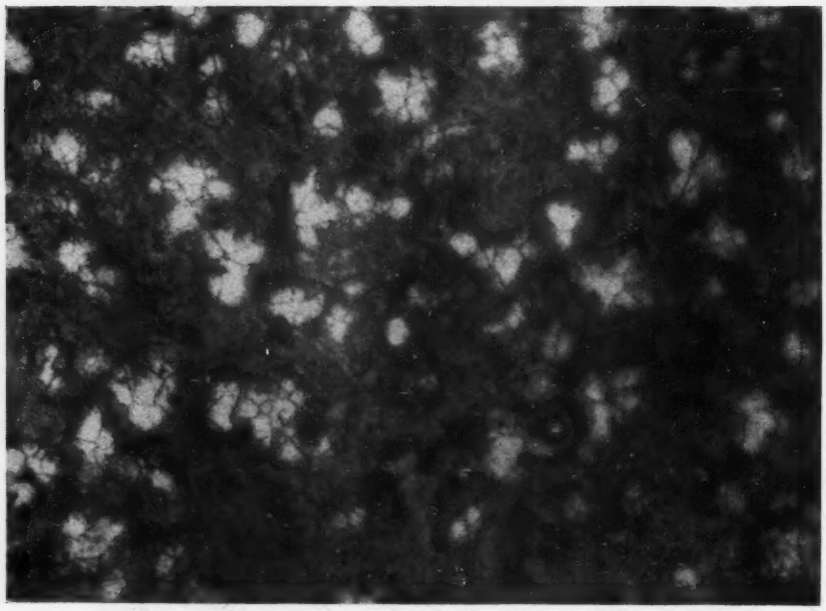


Fig. 9.—Same as Fig. 8. Shows platinum grain boundaries. Transverse view magnified 500 diameters.

It has been shown by microscopical investigators how stresses produce slipping along crystal planes inside the crystallites. If stresses are small, such slipping usually occurs where the metal is less homogeneous. At such places certain rises in temperature have been detected, showing that the metal actually works. Sound metal is only subject to elastic deformations.

Central segregation of this nature in the original round wire billet is the most difficult of all to detect. The machine that we use and which I shall show later on the screen, to detect segregation, in the flat cast, sometimes will fail to detect segregation in a round billet.

The field of the microscope is so small that all we have here is a quadrant.

Fig. 10.—The dark portion of the micrograph shows a quarter section of a segregated area that has been removed with the finest drill for purposes of identification by chemical analysis. Magnified one hundred twenty-five diameters.

You will note, however, that the metal which remains is perfectly homogeneous and the segregated area was all removed with the drilling. The very finest jewelers drill is used for this work.

Fig. 11 is a photograph of wire rods just after being cast. They are supposed to be solid solutions of a fairly homogeneous mixture of gold, silver, copper, platinum and palladium. To outward appearances, they are perfect. This, however, is not always the case. It has been shown by Edward Matthey in a series of experiments, that ingots containing five to twenty per cent platinum, do not possess a homogeneous structure. Segregation occurs and the platinum

is concentrated in the interior. The following is a chart prepared from Mr. Matthey's experiments.

Fig. 12 is self-explanatory. You will note that the alloy is ten per cent platinum and gold. That after being cast there was a difference between center and outside assays of almost six per cent. Different methods of treatment

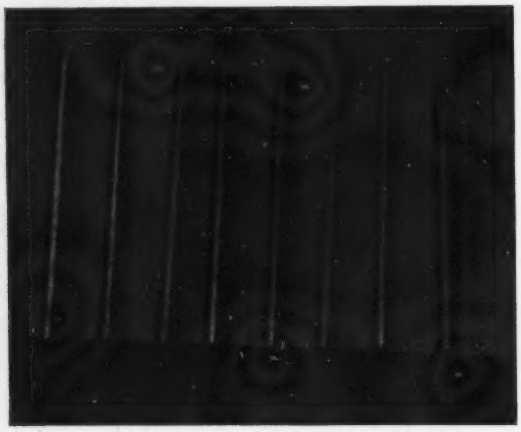


Fig. 11.—Group of wire billets just after casting, dimensions ½" x 7".

ALLOY OF GOLD + 10% PLATINUM

	ALLOY	MAXIMUM DIFFERENCE IN ASSAY BETWEEN CENTRE AND OUTSIDE PER 1,000.	REMARKS
1	AU. 900 PT. 100	58.9	
2	"	30.6	HEATED IN OIL FURNACE, MELTED SEVERAL TIMES AND THOROUGHLY STIRRED
3	"	19.7	No. 2 ALLOY REMELTED
4	"	27.2	No. 3 REMELTED IN OXY-HYDROGEN FLAME IN LIME FURNACE

Fig. 12.—Chart illustrating the difficulty in obtaining a uniform distribution of platinum.

brought it as low as approximately two per cent. This chart shows that a great deal depends upon the temperature of casting and emphasizes the importance of pyrometer control.

I might add at this point, that I carried out experiments in Dr. Fitzgerald's very extensive laboratory at Niagara Falls, N. Y., in which I cast ingots of gold and platinum at a temperature so high that I was in danger of

losing the end of my tongs when reaching in the furnace for a moment for the crucible. There was thousands of horsepower at our disposal and the temperature was so high that I would be afraid to even estimate it. The crucible and contents were absolutely invisible and it was only by wearing smoked glasses that I could discern its outline. The furnace was of the granular resistance type designed by Dr. Fitzgerald. I was seeking to eliminate segregation but found that terrifically high heat was no cure, in fact, carbon contamination from the furnace led to another difficulty.

Fig 13 shows an exaggerated phantom cut of approximately what occurs in a wire cast, containing a high percentage of platinum and in which the segregation is sufficiently great to cause cuppy wire when being swaged and drawn. You will note the shrinkage towards the center on the upper end of the cast. This is normal in most castings.

The extreme upper portion of these rod castings always seems to be more or less porous, especially at the center. This is due to the flowing of gases from the molten metal. The solidified metal usually shows a fissure or vent

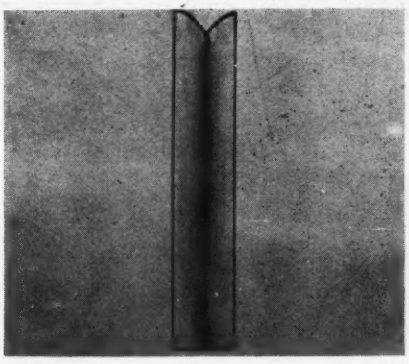


Fig. 13.—A phantom drawing showing what occurs in a complex platinum alloy billet. The darkened portion throughout the center represents the platinum segregation. The dark line at the top shows the "pipe" or "fissure" through which the gases escaped. It also shows the convex surface at the top of the billet caused by the shrinkage of the metal upon solidification.

through which these gases escaped. These fissures are generally known as "pipes." This "pipe" structure is supposed to be cut away from the sound metal before drawing but sometimes the melter is mistaken as to where this "pipe" ends.

Fig. 14, micrograph, was taken from the top of what was supposed to be a sound piece of metal. An inch or so was taken off the rod and then another specimen was placed under the microscope. You will again note the unworked casting structure.

Fig. 15 was the second result. The "pipe" is much smaller, but it is still there. It is necessary to cut off more metal. Before taking this second observation, the rod had been heat treated. You will note that the ingot or casting structure has disappeared. The metal is very homogeneous. Its only defect is due to the "pipe."

Going back several slides to the point at which I mentioned another cause for cuppy wire being over-draft, I referred to the following rather strange

Fig. 14.—Transverse section taken from the top of the billet after all of the "pipe" structure had presumably been removed. Shows typical casting structure, uniform distribution of platinum, also the "pipe" which was not visible to the eye. Wire drawn from this area would be defective. Magnified one hundred twenty-five diameters.

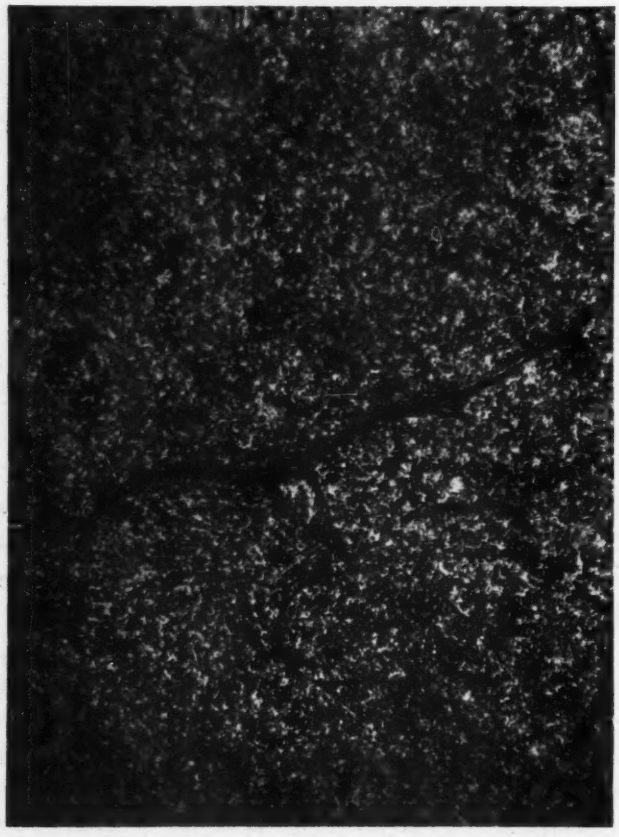


Fig. 15.—Transverse section of same metal as shown in Fig. 14 after several inches more had been removed from the top of the billet. The "pipe" is still visible although very greatly decreased in size. Due to annealing, the casting structure as shown in Fig. 14, has disappeared. Magnified one hundred twenty-five diameters.

condition. If too great a bite is taken into the metal, either swaging or drawing, the outer surface seems to draw to the exclusion of the interior.

Another source of trouble with wire is due to its splitting and breaking,

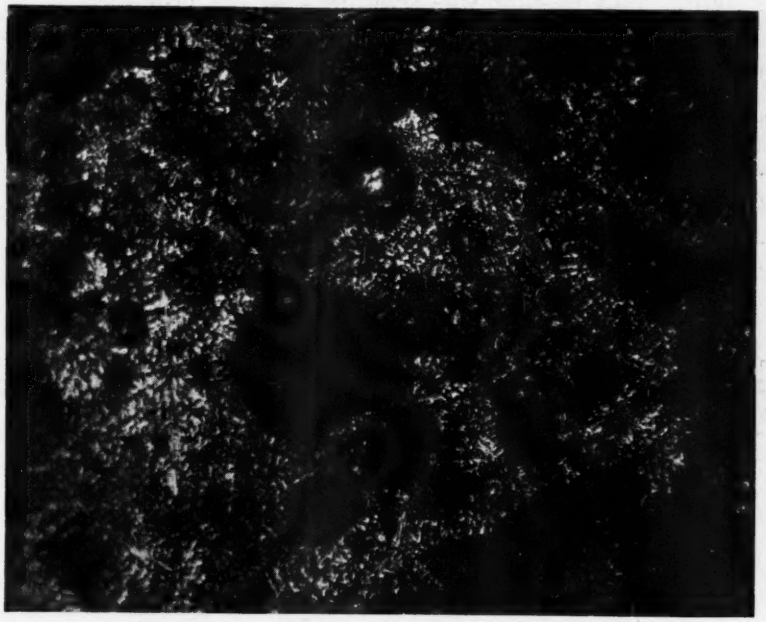


Fig. 16.—The first cast of a gold platinum alloy showing uniform distribution of platinum, but containing many blow-holes. Transverse view magnified one hundred twenty-five diameters.

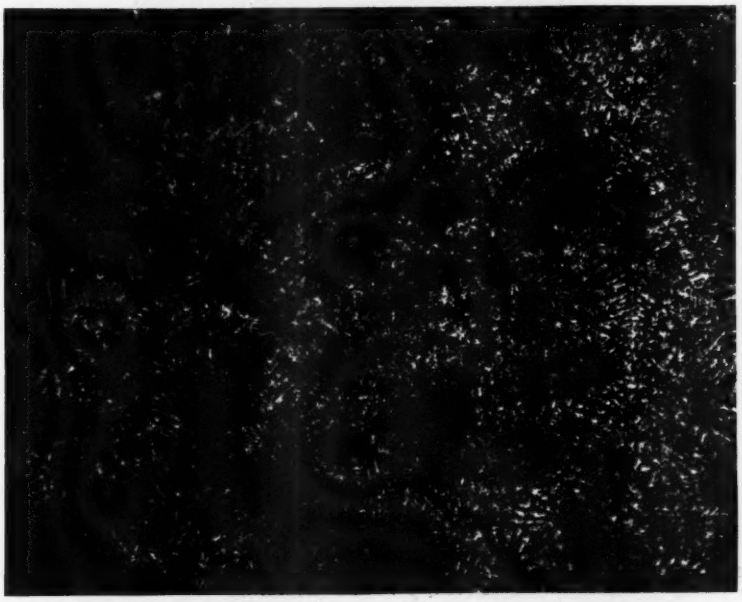


Fig. 17.—The second cast of the same alloy as shown in Fig. 16. The blow-holes are smaller in size and number, but a great many are still visible. Transverse view magnified one hundred twenty-five diameters.

especially at the ends, during the process of drawing and swaging. Again the microscope comes to our assistance and in some glaring instances, the eye or a small magnifying glass could detect the trouble.

Fig. 16 shows a cast saturated with small blow holes or bubbles. A cast of

this nature has no chance of ever becoming good wire. It will become brittle in spite of the most careful annealing. The exceptionally large circles are not dirt or foreign matter. They are simply blow holes that do not reflect the light. This casting was sent back to the crucible.

Fig. 17 is a recast of the same metal. There are still blow holes, but not as many or as large. Needless to say, it went back for another melting. In these last two slides, it is easy to observe the ingot structure.

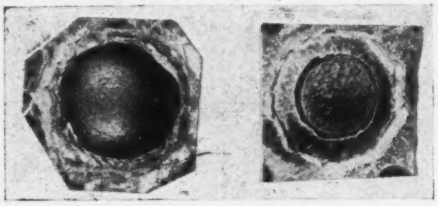


Fig. 18.—A small button of high grade casting gold. The figure on the left shows a very fine appearing outer surface. The figure on the right is the same button carefully filed into and polished. The button has been set up in a lead matrix.

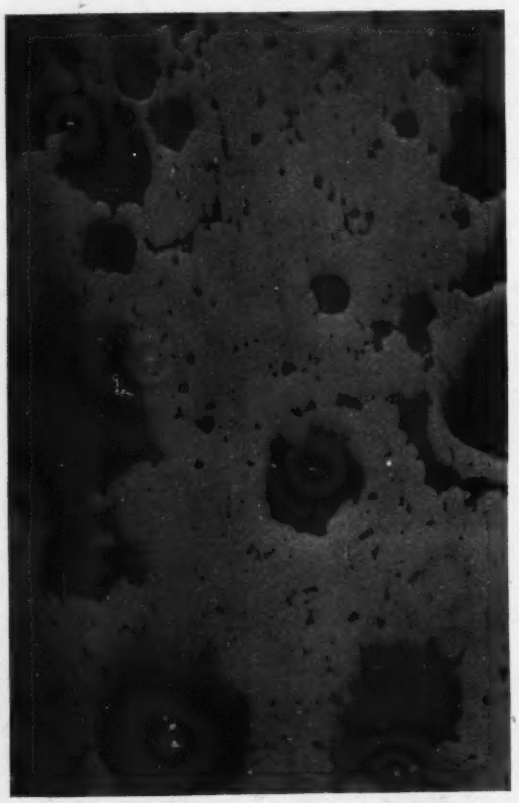


Fig. 19.—The button as shown in Fig. 18, polished but not etched. Magnified one hundred twenty-five diameters.

It would not be out of place at this time to show a few slides of exceptionally high-grade ingots of casting gold that I personally, very carefully melted into buttons under the blow torch.

Fig. 18 shows a button with as great a freedom from surface pits and eruptions as you could expect by melting under normal conditions. It could ordinarily be called a perfect casting. The outer ring is merely a set-

ting of lead to facilitate handling. The alloy contains 20 per cent platinum and palladium.

Fig. 19 is the same button carefully filed into, polished but not etched.

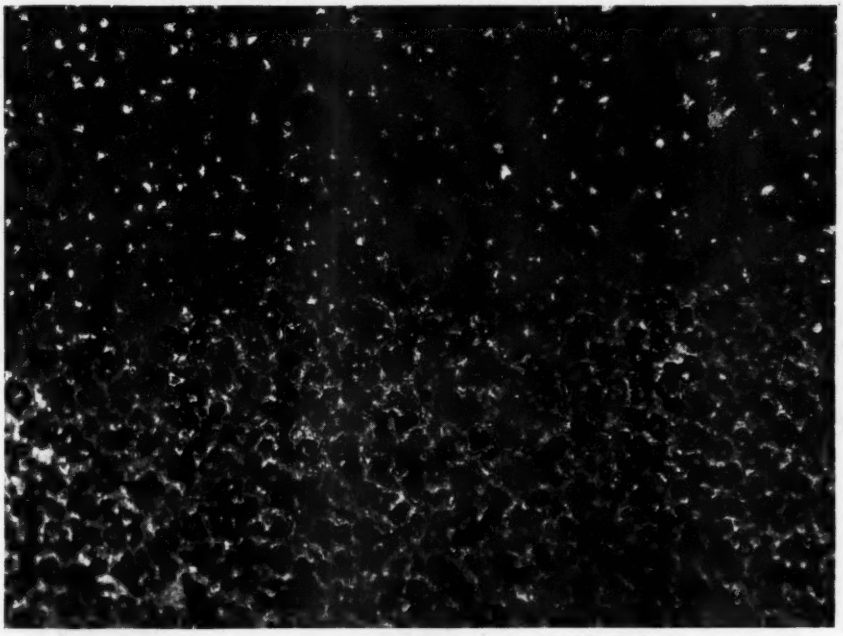


Fig. 20.—A small button cast from 6 per cent platinum alloy shows marked platinum segregation, but no blow-holes. Magnified one hundred twenty-five diameters.

Fig. 21.—A battery of wire furnaces, the melting and casting temperature controlled by the recording pyrometer shown in the left foreground.

It would be hard to conceive of a worse casting, yet the ingredients are the purest gold, platinum, copper, and silver.

Fig. 20 shows an ingot containing approximately 6 per cent of platinum.

The blow holes are gone but it is a fine example of segregation. I might go on at great length with slides of this nature but they would be only of interest to the general practitioner and have no place in this paper.

So much for the defects of wire. Now our method of overcoming them. In the first place we must have a casting free from blow holes and as homogeneous as it is possible to make it. Temperature control is a very important item.

Fig. 21 shows a battery of wire furnaces. The temperature of the various furnaces is automatically recorded on the pyrometer shown in the left foreground. This instrument is known as a Tapalogue. It accurately records the temperature of six furnaces at the same time. I will not go into a detailed description of this instrument, although needless to say, its function is important.

Suppose now that a wire casting is as nearly homogeneous as possible, shows no segregation or blow holes and works up perfectly. Does that mean that it will surely meet with the requirements of a particular job?

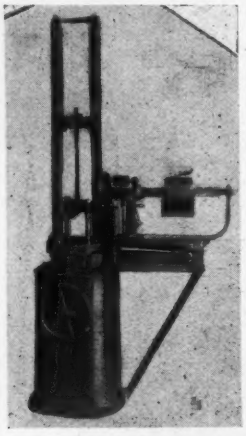


Fig. 22.—Instrument for determination of tensile strength.

Fig. 23.—Instrument for determination of hardness.

Referring to orthodontia, what are your particular requirements? Through the kindness and cooperation of Dr. Ellis, Dr. Hoffman, and Dr. Pullen of Buffalo, and others, I found out what properties your wire must possess. It must be springy and stiff and it must retain that springiness after being soldered to. It must also be sufficiently free from oxidation to allow for ready soldering. The soldering operation anneals the metal at the point of soldering, so we will sum it up by saying that the metal should possess high tensile after annealing. These gentlemen also stated that a good wire must stand up under bending without breaking. Then it is decided that you must also have certain torsion, and to gain torsion is to sacrifice tensile. A wire cannot be manufactured that possesses the maximum of both properties.

These are the desirable properties but how are we going to translate them into actual tangible figures of strain or stress.

Fig. 22. We can use a common tensile strength machine, such as this

for determining the first property, but without special attachments the instrument is slow and awkward to handle. It is, however, a wonderful instrument and should be the basis for occasional testing. But why not discard longitudinal strain and substitute a vertical pressure at a central point between two fixed pivots, and for purposes of comparison, over a constant area. In other words a perfectly simple little instrument that I will illustrate later.

This is an Olsen tensile testing machine. We use it to determine the tensile strength of small rods, rope, wires, etc. By the tensile strength of a

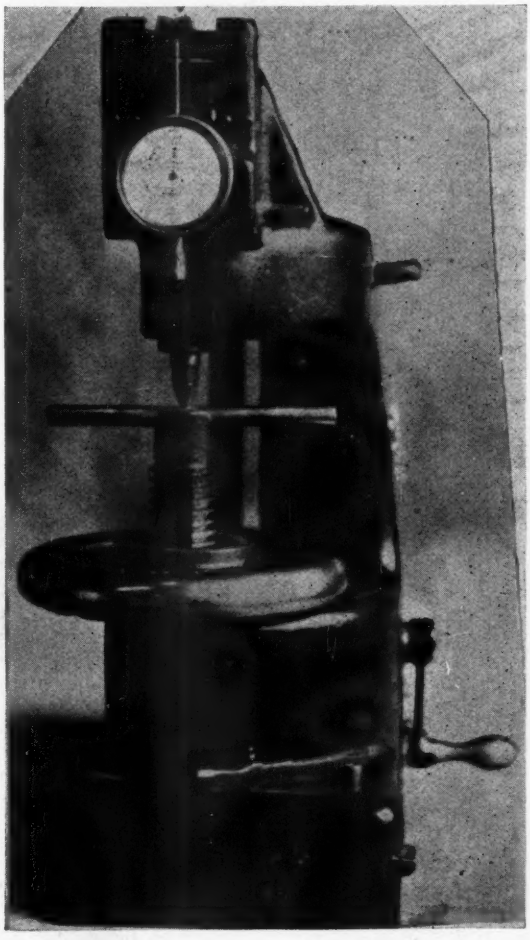


Fig. 24.—Direct reading instrument for determination of hardness.

material, we mean the unit stress that is required to break that material into parts. If a round bar two inches in cross section area will fracture under a strain of 24 tons, its tensile strength is 24 divided by two or twelve tons per square inch. Tensile strength is usually expressed in pounds per square inch.

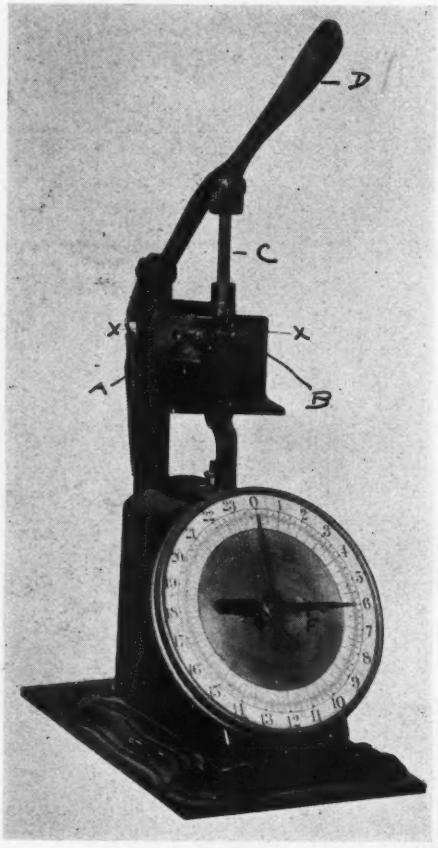
By elongation is meant the increase in length of a bar when its tensile strength is reached. If a bar ten inches long measures after rupture, 11.8 in., its elongation is 18 per cent.

Contraction is expressed by the decrease in cross section area in a bar

when its tensile strength is reached. If a bar one square inch is, after rupture, only .75 of a square inch in area, its contraction is 25 per cent.

There are special measuring instruments in connection with this machine to determine these later factors.

This instrument (Fig. 23) is a Brinnell Machine. It is simply a hydraulic press which forces a hardened steel ball or sometimes a diamond point into the metal to be tested. The force is usually measured in kilograms. The diameter of the indentation is measured with the small telescopic instrument shown at the lower left hand corner. We also use another



Figs. 25 and 26.—Instrument for determining strength of wires as used in routine production.

instrument with this machine for measuring the depth of the impression. It is interesting to note that this instrument will not make a round impression on pure gold in spite of the fact that a perfectly round point is being forced into the metal. Nor will the finest gold test uniformly under any instrument of this character. This is due to the flowing of the gold under pressure and I presume, in the direction of its crystalline cleavage planes.

The instrument that I use most frequently is shown in Fig. 24.

This is a Rockwell direct reading hardness tester. The principle is somewhat similar to the Brinnell but its action is much quicker.

Fig. 25 shows the instrument that I referred to in a previous part of my paper. I use it in place of the ordinary tensile machine to determine

the strength of the various wires. For purposes of comparison, the gauges of the various wires must be the same. Its action is very quick and it can be used in the routine production work.

Fig. 26 shows a platform scale to the top of which have been fixed two immovable grooved pivots *A* and *B*. These pivots are exactly one inch apart. Coming down vertically at a point central to *A* and *B* through a carefully machined bushing, is a grooved plunger *C*. The wire *X* to be tested for tensile strength, is inserted in grooves across pivots *A* and *B*. By a system of simple levers controlled by handle *D*, plunger *C* is slowly brought down on wire *X*. The dial hand *E* registers the weight in pounds and ounces that this wire is able to sustain. In order to facilitate the operation and to

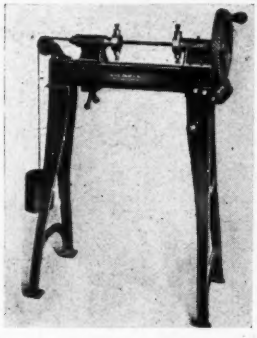


Fig. 27.—Instrument used for torsion test.

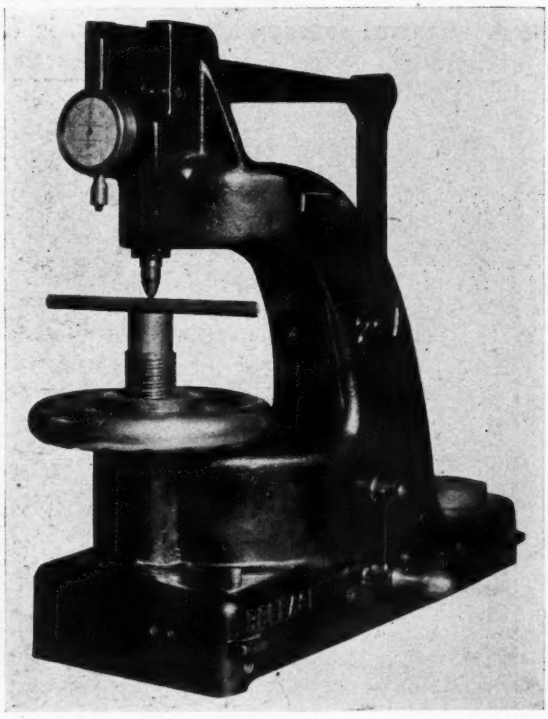


Fig. 28.—Hardness testing instrument used for detection of blow-holes and segregation.

make sure of catching the reading at its maximum point, we have auxiliary hand *F* that moves forward with *E* but does not return to zero. Thus hand *F* correctly records and holds the point at which according to our friend of centuries back, "the spring exerted its greatest tension."

As I am going to show a comparative chart in a few moments, I am going to ask that you keep this instrument in mind.

Fig. 27. So much for tensile, now for torsion. We have a perfectly simple instrument used by all wire manufacturing plants for determining this factor. A standard gauge of wire is fastened between two points and twisted until it breaks. The number of revolutions that it twists before breaking constitutes the torsion factor. This test is usually known as the twist test.

I have found out that although you must have some torsion, the tensile is by far the more important characteristic.

This all leads to the final method of attack. Let us subtract from torsion and give to tensile but to what limits can we go? In the first place, we start with an alloy, initially harder and springier than any we have used before. How do we know that this alloy is harder and springier? We use very simple standard instruments for this purpose. We have our choice of Brinnell machines, scleroscopic tests, scratch tests and the Rockwell instrument (Fig. 28).

If an alloy does not give uniform readings in this instrument, it should go back to the crucible for remelting. This slide shows a wire casting being tested. Central segregation, however, is difficult to detect in a cast of this

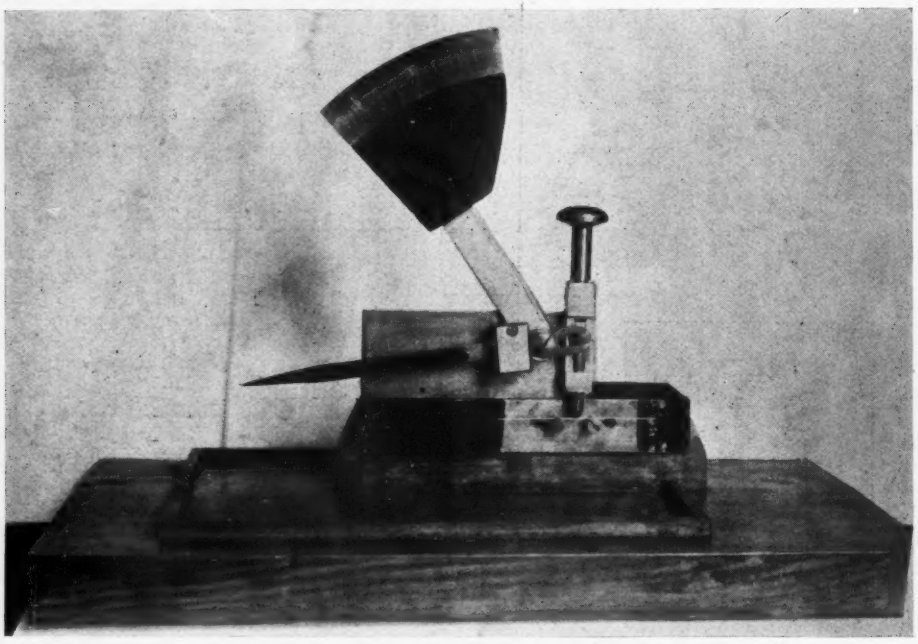


Fig. 29.—Instrument used for determination of elastic limit showing elevated position of movable scale.

kind and to be really thorough a section should be cut out and the rod tested across its diameter. If a great amount of platinum has been segregated in the center, the reading on the outer surface will be less and experience shows what that reading should be if the alloy is homogeneous. It is my opinion that wire should come from the factory thoroughly annealed, yet possessing sufficient tensile strength and a safety limit of torsion. An ordinary soldering operation should not then perceptibly affect these two important factors, and the operator who starts out to work the wire will at least have some idea of what its physical properties will be when he finishes it. Several manufacturers have already paid particular stress to this point.

Having determined definite factors for orthodontia wires, how are we to translate them quickly into standard measurements of elasticity and

strength. Having found nothing suitable on the market, I designed the following instrument.

Fig. 29. This instrument in ten seconds operation, gives the perfect elasticity factor of any wire. If read inversely, it will give the imperfect elasticity factor. Elasticity is directly proportional to our two much discussed factors, torsion and tensile. Tensile and torsion are directly proportional to hardness, hence all these properties can be determined on this perfectly simple, quickly operated little instrument.

You have your own standard. The best wire is the one possessing the greatest elasticity plus sufficient torsion. A test for sufficient torsion can be made by simply twisting into a loop with a pair of pliers. After thorough annealing, good wires of a fixed standard gauge, will show a P. E. factor of 16 and over. Poor wires drop as low as 8.

Fig. 30. This is the instrument on which I based all of my final tests.

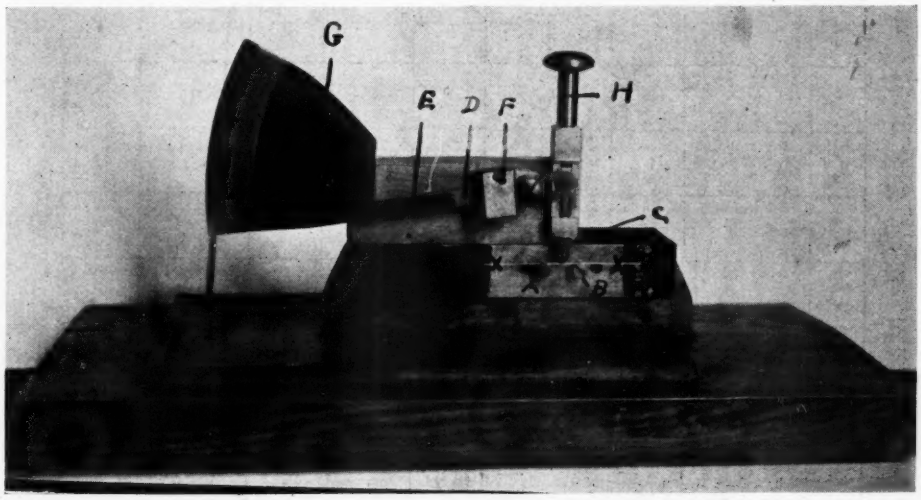


Fig. 30.—Same instrument as shown in Fig. 29, with movable scale depressed.

Wires for purposes of comparison must be all of the same gauge and must all be subjected to the identical annealing treatment.

On this instrument there are two fixed grooved pivots *A* and *B*, exactly one inch apart. Plunger *C* operated by hand pressure comes down vertically on wire *X*, at a point equally distant between points *A* and *B*. On plunger *C* is attached arm *D* to which in turn is attached indicator hand *E*. On arm *D* is also attached counter balance weight *F*. To the body of this instrument is also attached movable dial *G*. On the top of plunger *C* is the movable knob or handle *H*. This can be screwed up or down so as to regulate the stroke of plunger *C* on wire to be tested *X*. Movable dial *G* is divided, with the point of attachment on the instrument as a radius, into the common inch scale. A movement of one sixty-fourth of an inch of the dial hand is represented by a movement of two one-thousandths on plunger *C*.

We select an arbitrary distance on dial *G* to depress all wires of like gauge. This distance can be regulated by movable handle *H*.

When the wire *X* to be tested is depressed by plunger *C* with the mova-

ble dial *G* set at zero, to a point on the dial previously determined, the weight is then released and due to the elasticity of the metal indicator hand *E* springs back. But if we have gone beyond the elastic limits of this metal, it will not go back to zero. For this reason, we fix the length of the stroke

COMPARATIVE SCALE
DRILL ROD - 85
PURE GOLD - 20

HARDNESS

	BEFORE ANNEALING	POINTS VARIATION	AFTER ANNEALING	POINTS VARIATION	GREATEST DIFFERENCE	HARDNESS RATING	SPRINGINESS FACTOR (AFTER ANNEALING)	SPRINGINESS RATING
1	43 - 84 40 - 81	3	36.5 - 72 36 - 70 36 - 70	2	14	8	34.50	11
2	39 - 79.5 39 - 82	2.5	38 - 75 37.5 - 75	0	7	4	37.25	7
3	41 - 85 43 - 86	1	38 - 75 37.5 - 75 38 - 74	1	12	5	36.83	8
4	41.5 - 83 41.5 - 85	2	33.5 - 76 39 - 78 39 - 78 30 - 72 39 - 73 38 - 76	6	13	3	40.58	4
5	39 - 81 40 - 81	0	38 - 75 37.5 - 75	0	6	4	37.25	7
6	38.5 - 80 39 - 81	1	36 - 70 36.5 - 70	0	11	9	34	12
7	38.5 - 79 38 - 79.5	.5	37 - 74 35 - 74	0	5.5	5	37	7
8	38 - 81 42 - 84	3	36.5 - 72 37 - 73 37 - 73	1	9	7	35.83	10
9	38.5 - 78.5 38.5 - 79 39 - 79.5	1	37 - 75 37 - 75 37 - 75	0	3.5	4	38	5
10	38.5 - 79.5 38.5 - 80	.5	36 - 72 36 - 73	1	5.5	5	37.50	6
11	43.5 - 87 41.5 - 84.5 40 - 83 38.5 - 80 38.5 - 80.5	7.5	38 - 76.5 38.5 - 78	1.5	7	2	41.75	2
12	39 - 81 39 - 80	1	37 - 73 37 - 73	0	8	6	36.50	9
13	38 - 78 38 - 80	2	34 - 75 37 - 74 37 - 75	1	6	5	41	3
14	38 - 88 40 - 84	4	38 - 81 38 - 81 38 - 82	1	9	1	44	1

Fig. 31.—Comparative hardness chart of different spring wires purchased on the market. The figures in the extreme left hand column, 1-14, represent the different wires tested. Take for example No. 1. One end showed a hardness of 84, the other end 81. This variation is too great. The metal is evidently not uniform in composition. However, we are not sure about this point until we see whether this variation in hardness is not due to nonuniform annealing. We anneal now very carefully in an electric furnace at 800° C., allow the wire to cool slowly in the air and test again. This time we take a reading at both ends and one in the center. The hardness has dropped from 84-81 to 72-70. In other words, the structure is not homogeneous and the metal is about 16 per cent softer.

The column headed "Greatest Difference" shows this variation in hardness before and after annealing for all of the wires.

The fourth column, headed "Points Variation" shows a lack of homogeneity in the wire. The greatest loss of hardness after annealing was 16 per cent, the least was 4 per cent.

Under the column headed "Hardness Rating," the wires are listed according to their value. Several were entitled to the same rating, hence the numbers did not spread out to 14.

This instrument is also capable of giving a certain springiness factor. These values are placed in the second to last column. We arrived at these values by subtracting the primary from the secondary reading. These two groups of readings will be observed in the first and third columns.

Wire No. 14 is by far the hardest of the group, and as you will note, also the springiest. This shows the direct relationship between hardness and springiness.

to go well beyond this limit. Now if we read the zero to the present position of the dial hand, we read the factor of imperfect elasticity. If, however, we move up this dial to make the zero point coincide, with the present position of the dial hand, we automatically subtract the range of imperfect elasticity. Now by depressing plunger *C*, we have a direct reading or perfect elasticity and no matter how much the wire is depressed, with that same fixed stroke, the hand will always go back to zero. When the elastic limit of a wire is not exceeded, there is no interior crystalline disturbance. The figure we now read is the one shown by the hand with plunger *C* de-

LBS. SUPPORTED BY ONE INCH LENGTH

COMPARATIVE SCALE
PIANO WIRE - 7 LBS. 8 OZ.
PURE GOLD - 0 - 4 -

VERTICAL PRESSURE

	BEFORE ANNEALING LBS. - OZ.	AFTER ANNEALING 1 MINUTE CHERRY, RED LBS. - OZ.	% LOSS OF STRENGTH	AFTER ANNEALING 10 MINUTES-1400°F. LBS. - OZ.	% LOSS OF STRENGTH	ULTIMATE % LOSS OF STRENGTH	RATING
1	3 - 0	1 - 6	54	1 - 4	9	63	9
2	2 - 9	1 - 4	66	1 - 4	NONE	66	10
3	3 - 7	1 - 9	55	1 - 8	4	59	8
4	2 - 15	1 - 13	38	1 - 13	NONE	38	4
5	2 - 10	1 - 6	48	1 - 5	4.8	52.8	9
6	2 - 8	1 - 4	50	1 - 1	15	65	10
7	2 - 6	2 - 0	16	1 - 8	25	41	3
8	2 - 15	1 - 3	60	1 - 3	NONE	60	11
9	4 - 1	3 - 7	15.4	3 - 7	NONE	15.4	2
10	2 - 4	1 - 10	27.8	1 - 9	3.85	31.65	7
11	1 - 13	1 - 12	35	1 - 6	21.5	25.0	5
12	2 - 4	1 - 11	25.0	1 - 10	3.7	28.7	6
13	2 - 8	1 - 9	37.5	1 - 9	NONE	37.5	8
14	4 - 4	3 - 8	17.7	3 - 8	NONE	17.7	1

Fig. 32.—Chart showing comparative tensile strength tests on the different wires purchased on the market. Take for example Wire No. 1. Before annealing, this wire was able to sustain a weight of 3 lb., 0 oz. After annealing for one minute at cherry red and cooling slowly in the air, it could only sustain a weight of 1 lb., 6 oz. It lost 54 per cent of its strength. The wire was annealed again for ten more minutes. It showed a further loss in weight sustaining power of 2 oz. or an additional 9 per cent. Its final loss of strength was 54 per cent plus 9 per cent, or a total of 63 per cent. These wires were all submitted to this test and roughly rated in the last column. The value rating is not based on the percentage of loss of strength after annealing, but on its final weight sustaining power; for instance No. 14 showed a final loss of 17.7 per cent, No. 9, 15.4 per cent, yet No. 14 is rated ahead of No. 9. This is due to No. 14 sustaining 3 lb., 8 oz. against 3 lb., 7 oz. for No. 9.

According to the chart, the best wire sustained over three times the weight of the poorest.

pressed to the fixed limit from which we have subtracted everything beyond the range of perfect elasticity.

My last slides will show a comparison of most of the orthodontia wires on the market. The gauges that I purchased were twelve and twenty. I used the former for hardness tests and the latter for tensile and elasticity. As this particular work was done last December, possibly newer wires have been brought out since that time. Some of these wires were good indeed, others exceedingly poor.

Fig. 31 represents the hardness of the various wires and after a fashion

RANGE OF PERFECT ELASTICITY
OR
ELASTIC LIMIT

COMPARATIVE SCALE
PIANO WIRE - 26
PURE GOLD - .2

	BEFORE ANNEALING	AFTER ANNEALING 1 MINUTE 800°C.	% LOSS ELASTICITY	ADDITIONAL ANNEALING 10 MINUTES 500°C.	% LOSS ELASTICITY	ULTIMATE % LOSS ELASTICITY	RATING
1	19	10	47.3	10	NONE	47.3	8
2	19	12	36.8	10	16.7	47.3	8
3	22	13	40.9	13	NONE	40.9	5
4	18	16	11.1	16	NONE	11.1	3
5	19	12	36.8	10	16.7	47.3	8
6	19	10	47.3	10	NONE	47.3	8
7	20	17	15	15	NONE	15	4
8	21	10	52.4	10	NONE	52.4	8
9	20	17	29.2	17	NONE	29.2	2
10	18	13	27.9	12	7.7	33.4	6
11	18	15	27.8	10	33.33	44.5	8
12	19.5	12	38.5	11	8.35	43.5	7
13	21	12	43	12	NONE	43	6
14	22	20	10%	20	NONE	10	1

Fig. 33.—Chart showing elastic limit of various wires purchased on the market. Take for example, wire No. 1. Before annealing, this wire showed an elasticity number of 19. After annealing for one minute at 800° C. the elasticity number dropped to 10. Its percentage of elasticity loss was 47.3. It was annealed for ten more minutes. It did not lose any additional elasticity. Its final total loss was 47.3 per cent.

The last column is a rough rating of all the wires. As in the previous table, the comparative rating is not based on the percentage loss of elasticity. It is based on the final elasticity number, and of course the higher the number, the better the wire.

All wires showed a loss of elasticity after annealing. The poorest elasticity number was 10. You will note that there are several 10's. The best was 20, or in other words, it possessed twice the elasticity.

an elasticity factor. Readings were taken at each end of a six inch length of wire and in some instances at various points in between. To give you a comparative scale, drill rod untempered shows a hardness of 92. Pure gold 20.

Fig. 32 shows the tensile strength of the various wires. As a standard, you will note that piano wire shows a strength of seven pounds, eight ounces, pure gold no pounds, four ounces. The unit of measurement is pounds and ounces. The instrument has been shown and explained in a previous part of my paper.

You will note the vast difference between some of the wires and the sad loss of strength of the great majority of them after annealing.

Fig. 33 is a comparative chart of the perfect elasticity of the various wires. As a standard, piano wire shows an elastic limit of 26. Pure gold .3. A factor after annealing of 16 and over is good. Eight and under is poor. You will note all the way through a definite ratio between hardness, tensile and elasticity. If I were to depend upon one instrument, I would use this one.

You will note the outstanding wires on these charts. They are No. 14 and No. 9. No. 14 was made up from a special alloy, and was the result of several months' experimenting. Samples were submitted to several orthodontists throughout the country. They all came back with the same criticism. It was so stiff that it could not be worked. If they did force a bend, the wire broke. In other words, tensile was overdone to the detriment of torsion. I would like, at this time, to show you a picture of this wire. The sample was well annealed, yet the worked structure still remains.

Figs. 34 and 35. You will note its exceptionally dense uniform structure. It appears almost like tool steel and in fact has greater tensile strength than tool steel untempered. It was with great regret that I abandoned this alloy. It contained 23 per cent platinum and palladium.

Fig. 36. In order to make sure that I was testing over a constant area, I carefully micrometered the wires and noted the amount of error. You will see that in no case was it a great deal and they were all fairly close to gauge. About ninety-five per cent were over size instead of under, due, I presume, to the wear of their drawing dies.

To obtain the maximum springiness in a wire, we sometimes attack from this angle. We start with an alloy of definite uniform hardness. The microscope shows no great segregation and there are no blow holes. The hardness factor is much greater than a previously known and well tested standard product of the same plant. We find, however, that in working it up, in spite of our best efforts to anneal and soften, it becomes brittle and unworkable. Our next step is to prepare a new alloy, eliminate a small percentage of the hardening metals and try again. Eventually we get a metal that works up into a flawless springy wire. When you consider that dozens of attempts are sometimes necessary, and each attempt represents several hundreds of dollars tied up that can only be recovered through refining,

you can see that it is not feasible for an individual to attempt this research work.

Fig. 34.—The experimental wire which occupied position 14 in the comparative tests. It contained 23 per cent platinum and palladium. The alloy was found to possess too great a tensile strength and not sufficient torsional qualities. The structure is exceptionally dense and uniform. Longitudinal view magnified one hundred twenty-five diameters.

Fig. 35.—The same metal as shown in Fig. 34. Longitudinal view magnified five hundred diameters.

I am going to show several charts describing my experience with various methods of heat treatment, and hot and cold plunging. Before starting

these experiments, I made up a new wire based on past experiences. This is the wire.

Fig. 37 is a transverse view. You will note the very uniform distribution of platinum.

Fig. 38 is a longitudinal view. The wire has been annealed yet the worked structure still remains.

ERROR IN GAUGE

12 GA. - .0808
20 GA. - .0319

PHYSICAL APPEARANCE

	GAUGE ORDERED	GAUGE RECEIVED	ERROR	SLIVERS	BLISTERS AFTER ANNEALING	REMARKS
1	12	.082	+ 0012	NONE	NONE	ALL WIRES GOOD
	20	.032	+ .0001			
2	12	.081	+ 0002	NONE	NONE	
	20	.032	+ .0001			
3	12	.0805	- 0003	NONE	NONE	
	20	.0325	+ .0006			
4	12	081	+ .0002	NONE	NONE	
	20	.033	+ .0019			
5	12	.0815	+ .0007	NONE	SLIGHT POROSITY APPEARANCE	
	20	.032	+ .0001			
6	12	.081	+ .0002	NONE	NONE	
	20	.032	+ .0001			
7	12	.080	+ .0008	NONE	NONE	
	20	.031	- .0009			
8	12	.083	+ .0022	NONE	NONE	
	20	.032	+ .0001			
9	12	.0795	- .0013	NONE	NONE	
	20	.034	+ .0031			
10	12	.080	- .0008	NONE	NONE	
	20	.032	+ .0001			
11	12	.0805	- .0005	NONE	NONE	
	20	.032	+ .0001			
12	12	.075	- .005	NONE	NONE	
	20	.032	- .0001			
13	12	.082	+ .0012	NONE	NONE	
	20	.032	- .0001			
14	12	.089	+ .0082	NONE	NONE	
	20	.032	+ .0001			

Fig. 36.—Chart showing error in gauge of various wires purchased on the market. Wire No. 9 of this chart consistently showed well up to the front in all of the comparative tests; in fact, in most instances, just behind the special experimental wire No. 14. The reason for this exceptional showing is very apparent. The error in the 20 gauge size is .003. The instruments testing over a greater area, gave relatively higher readings. The gauges of all the wires were oversize due presumably to the wear of the dies.

Wire No. 14 was only .0001 oversize. That amount of error is excusable even in a diamond die.

A careful study of this heat treatment chart (Fig. 39) might be of considerable value. At the upper left hand corner is a test run on piano wire and pure gold. This will give you some idea of the relative numerical values.

Fig. 37.—New wire, alloy, based on previous experience and designed to give maximum tensile strength yet possessing sufficient torsional qualities. Transverse view magnified one hundred twenty-five diameters.

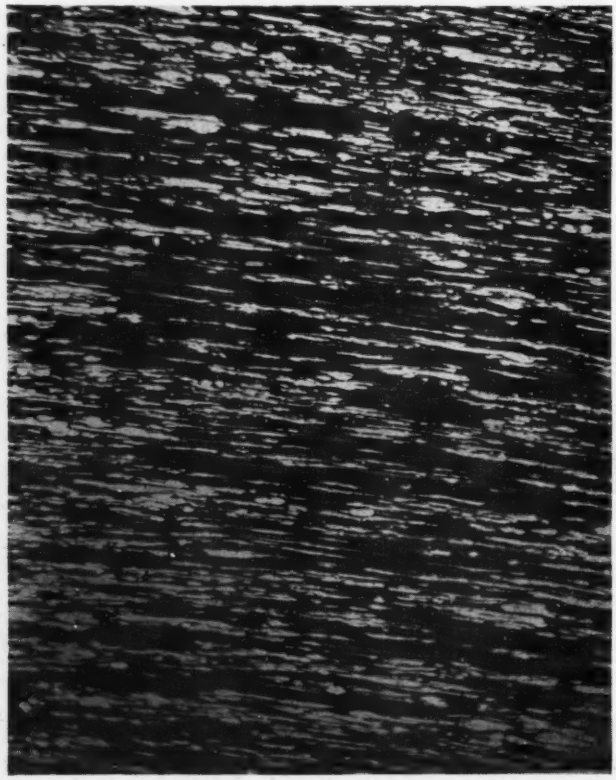


Fig. 38.—The same wire as shown in Fig. 37. The wire has been annealed, causing the slightly rounded appearance of some of the crystalline groups. Longitudinal view magnified one hundred twenty-five diameters.

At the upper right hand corner, are three temperature estimations. Boiling water, a metal glowing in the dark and cherry red.

In order to obtain the maximum uniformity in a coil of wire before starting experiments, I carefully annealed the coil for ten minutes in an electric resistance furnace, at 745 degrees C. The tested length showed uniform results. Heating to cherry red in a gas flame and air cooling increased slightly both its strength and elasticity. The data on tempering at 172 degrees C. is rather astonishing. It shows the extremely low heat at which the maximum degree of tempering can be accomplished. Also the time element seems to be a fairly important factor. By tempering five minutes, the elasticity is increased 21 per cent.

HEAT TREATMENT.

Comparative scale.

Piano Wire Elasticity --26 Strength --7 lbs. 0 ozs.

Pure Gold " --00.2 " --0 " 4 "

Temperature estimation.

Boiling water --100°C.

Glowing in dark--525°C.

Cherry red --900°C.

	Elasticity.	Strength. lbs.	ozs.	
Annealed 10 minutes at 745°C. electric furnace, Cooled in air.	15	2	6	
Heated cherry red, gas flame. Cooled in air.	15+	2	7	
Tempered on hot plate 172°C. 5 minutes	19	3	3	
10 "	20	3	5	When reheated to cherry red,
15 "	20+	3	6	all wires dropped to,
20 "	21	3	5	15 and 2 lbs. 6 ozs.
40 "	21	3	2	
120 "	18	3	0	
Tempered on hot plate 358°C. 5 minutes.	17	3	1	
Tempered on hot plate 400°C. 10 minutes	19	3	4	
15 minutes	19	2	15	

Fig. 39.—Heat treatment chart showing the effect of increased temperature and time on the elastic limit and tensile strength of spring wires.

It is noted, however, that there is a gradual decrease in both strength and elasticity when tempering for a period longer than twenty minutes. It seems that after this period of time the operation becomes an annealing and softening one instead of tempering. These tempered wires when heated to cherry red, all dropped back to their original condition. Tempering at higher heat did not prove to be of any advantage, in fact, as shown by the chart, was even detrimental.

The question is naturally asked, what takes place when gold platinum wires temper at such a low heat? This condition is not only true of gold-platinum wires. Some brasses exhibit the same properties. Under certain conditions of heat treatment, they are absolutely unmachineable. Some

aluminum and zinc alloys show the same characteristics. In order to be workable, they must be quenched from 800 degrees Centigrade.

I don't wish to take up the matter of equilibrium diagrams or cooling curves, for at the present time, I have not undertaken this research work with gold-platinum complex alloys. I hope to, in the near future.

Edward Mathey, however, has found three distinct solidifying points in an alloy composed of gold, copper, zinc and lead. They were at 767 degrees C., 645 degrees C., and 206 degrees C. This last temperature approaches our tempering point.

The slides that I shall show, give some explanation for this increase in strength. According to the Rosenhain and Ewen theory, the boundaries between adjacent grains are not merely surfaces of contact, but narrow spaces filled with amorphous metal or cement, holding the grains together. Metals exhibiting this marked property show greatly increased strength.

Figs. 40, 41, 42, and 43 show wire heated to cherry red and pickled immediately. You will note a homogeneous structure, but no marked grain boundaries.

Figs. 44 and 45 show wire heated to cherry red, cooled in air and tempered at 172 degrees C. for five minutes. Note the marked grain boundaries.

Fig. 46, showing the results of experiments with different pickling solutions, and quenching media, will merit considerable study and leads to very definite conclusions.

There is no appreciable difference as to what cold liquid chills the hot wire. The physical effects of the different acids and even cold water, is the same. By plunging the wire hot, there is a loss of elasticity of 12½ per cent and loss of strength of 12 per cent. It is noted, however, that when the wires are again heated to cherry red and allowed to cool in the air, they regain their strength and elasticity. This air cooling has a decided tempering effect. However, it is noted that if the air cooled wire is boiled in pickle to clean off the oxide, there is a loss of elasticity of 6 per cent and a loss of strength of 2½ per cent. I believe the reason that my instrument does not show a loss of strength comparing approximately to the loss of elasticity, in wires that have been cleaned in acid, is due to the magnification of one of its sources of error, namely, friction of the wire on the fixed pivots. If the oxide surface is cleaned off, the traction seems greater. In order to make sure about this loss of elasticity and strength from mere boiling in acid, you will note that I repeated the experiment using an entirely new wire but of the same alloy. The same result was obtained. If the wires were tempered, however, they regained all of their lost strength and elasticity showing that the damage done may be corrected. By tempering a wire after plunging hot, there is a gain in elasticity of 30 per cent and a gain in strength of 35 per cent. If, however, the tempered wire is subjected to boiling in acid, there is a loss in elasticity of 7½ per cent. There seems to be no loss in strength.

Investigation as to the reason why pickled wire should lose strength

Fig. 40.—Spring wire used in heat treatment tests. The wire has been annealed to cherry red and plunged into pickling solution. Transverse view magnified one hundred twenty-five diameters.

Fig. 41.—Same wire and treatment as shown in Fig. 40. Longitudinal view magnified one hundred twenty-five diameters.

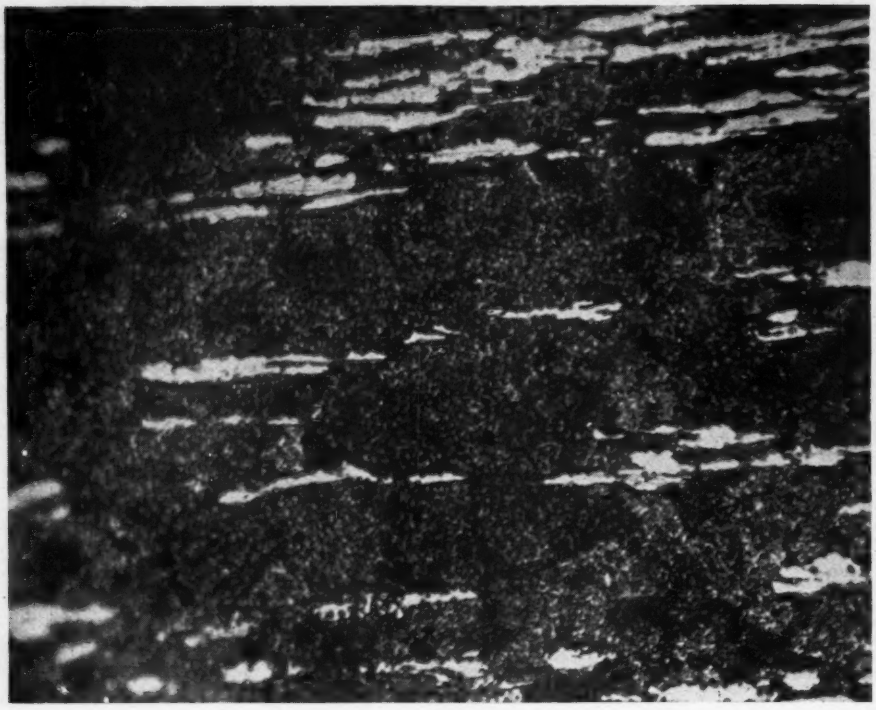


Fig. 43.—Same wire and treatment as shown in Figs. 40, 41, and 42. Longitudinal views magnified one thousand diameters.

Fig. 42.—Same wire and treatment as shown in Figs. 40 and 41. Transverse view magnified five hundred diameters.

Fig. 44.—Spring wire similar to Figs. 40, 41, 42, 43, annealed to cherry red, allowed to cool in air and tempered for five minutes on a hot plate at 172° C. The back ground has coalesced into rounded crystalline grain boundaries. Metals exhibiting this structure show greatly increased tensile strength. Longitudinal view magnified one hundred twenty-five diameters.

Fig. 45.—Metal and treatment similar to Fig. 44. A comparison with Fig. 43 will readily illustrate the change in crystalline structure due to tempering. Longitudinal view magnified one thousand diameters.

and elasticity, showed that it was due to hydrogen absorption. This can be very simply demonstrated in any laboratory. Boil a wire in any acid, wash it carefully and boil in distilled water. After a few minutes, small bubbles can be observed clinging to the wire. In the general wire manufacturing trade, this is known as acid brittle wire. Their method of treatment after pickling, is to soak for a period of hours in a vat containing rye meal solution. This soaking removes the hydrogen. Hydrogen absorption opens a very interesting field for metallurgical research in dentistry. It might be possible that the stiffening of wires or other appliances while in the mouth is due to the occluding of hydrogen. The hydrogen absorbing property of palladium is especially pronounced. I did not undertake any experiments to determine whether or not wires containing larger amounts of palladium show a corresponding decrease, after pickling, of strength and

QUENCHING AND PICKLING SOLUTIONS.

Comparative Scale

Piano Wire Elasticity-- 26 Strength-- 7 lbs. 8 Ozs.

Pure Gold " -- 00.2 " -- 0 " 4 "

	Elasticity.	Strength. Lbs.	Ozs.	Remarks.	
Heated to cherry red and plunged into.				All wires when heated to cherry red and cooled in air, returned to approximately, I6 and 2 lbs. I0 ozs.	Approximate loss when plunged hot.
Cold water	I3.5	2	5		Elasticity I2½ %
20% H_2SO_4	I4.5	2	6		Strength I2 %
20% HNO_3	I4.0	2	6		
20% HCl	I3.5	2	5		
Heated to cherry red Cooled in air. Boiled in 20% H_2SO_4	I5.0	2	9		Loss if boiled in acid. Elasticity 6 % Strength 2½ %
Same treatment as above, new wire, same alloy.	I4.5	2	9	Tempered on hotplate I72°C. 5 minutes. 20. 3lbs. 4 ozs.	Gain if tempered 5 minutes Elasticity 30 % Strength 35 %
Tempered on hot plate 5 minutes at I72°C.	20.0	3	4	Boiled ten minutes 20% H_2SO_4 I8. 3 3 lbs. 4 ozs.	Loss after tempering if boiled in acid. Elasticity 7½ % Strength 0 %

Fig. 46.—Chart showing the effect of different pickling solutions on the tensile strength and elasticity of spring wires, also the gain in tensile strength and elasticity through tempering.

elasticity. I know, however, that tempered wires will not occlude hydrogen. The following is a very interesting experiment. Heat a wire to cherry red and pickle at once. Hold the wire in a pair of pliers and anneal one-half of its length to a cherry red. Allow it to cool in the air. Place the wire in a beaker filled with distilled water. Heat the beaker slowly over a Bunsen burner. Bubbles of hydrogen will form only on the portion of the wire that has not been annealed. This shows that the heat of boiling water is sufficient to occlude the hydrogen.

CONCLUSION

I have tried to cover the subject of orthodontia wires from an angle not heretofore approached or at least to my knowledge, never published. You will probably note that I have very carefully avoided formulae. A good many formulae have already been published. I think that the greatest

trouble we have had has been due, not to formulae, but to nonuniformity. This has been clearly demonstrated by the comparative charts, when several wires of presumably the same alloy, differed widely in their characteristics. I think that the problem is primarily one of the manufacturers. I believe, however, that the standard of wire is getting much better and much more uniform. Needless to say, any apparatus that I have at the present time is entirely at your disposal, either working individually or as a committee.

In closing, I might give the following advice. If you can spare the time, heat all of your wires to cherry red before bending. If the particular plant that manufactured your wire does not have annealing furnaces with pyrometer control, the workman might have been careless and missed with his blow torch, that particular piece of wire with which you are working. Hard drawn unannealed wire can have many a small fracture from bending, unobserved by the naked eye. Experiments show that none of the wires have been thoroughly annealed. They all lost some elasticity.

Again as a last word, if you don't wish to lose outright, 12 per cent of the effectiveness of the wire, do not plunge hot in any liquid. If you wish to gain an additional 25 per cent, temper for a few minutes on a hot plate at a very low heat. If you don't wish to lose 7 per cent of this additional 25 per cent, clean off with soda or pumice and do not boil in pickle.

I am very happy to have been able to give what information I might have, to this Society and only trust that my subject has not been treated at too great a length. Thank you.

DISCUSSION

Dr. Ralph Waldron, Jersey City, N. J., I think we have listened to one of the most remarkable papers on metallurgy ever presented before this or any other orthodontic society, and at the outset I wish to congratulate both Mr. Williams and the American Society of Orthodontists. The former for his truly scientific presentation of such a timely, though almost uncomprehended subject, and the latter for being the recipient of such a valuable contribution to orthodontic science.

As most of you remember, a few years ago I conducted a series of experiments on the elasticity of gold-platinum alloys, but the results of these findings were such that I could not publish them. I found most of these alloys were not dependable, and only the products of a few manufacturers would repeat the same result at subsequent tests, while the majority were undependable, as regards their constant elasticity, though treated alike. Ofttimes, one foot of .035 wire could be divided into two six-inch pieces, and both pieces would vary as to their elasticity.

Before discussing this paper, which deals with a spring force, we must have an understanding, and be fully agreed upon the definition of a spring, and meaning of spring force.

A few years ago, Dr. J. Lowe Young asked some of the members of this society, and particularly the orthodontic teachers in our dental school, for the definition of a spring, and some time later he gave for our consideration and adoption the following definition: "A spring is a piece of inanimate material, in such relative proportion as to length and diameter, that when deflected by a force, and that force again removed, that material will come back to its original form and position." I think this is the definition adopted by this society.

If we should take a block of steel one inch square, we would have practically no spring. But if we would roll or draw that cube of steel into a six-foot rod we would have a spring. Again if we should take that one-inch cube of steel and split in into five hundred pieces in one direction, and again into five hundred pieces in another direction, we would have five hundred times five hundred or two hundred and fifty thousand springs, because it is necessary to have material in such relative proportions as to length and diameter, before we can have a spring.

I think we are all agreed upon this definition of a spring, and we know of no other way of stimulating cell activity thereby producing bone growth and causing teeth to move into the line of occlusion, than by the constant yet gentle pressure of this spring force.

It, therefore, behooves us to master the dynamics of these spring forces that our cases may be brought to a successful termination.

There is one portion of this paper which is contrary to my opinion regarding the elasticity of flexion, and the elasticity of torsion.

I think the majority of us regard the elasticity of flexion as that elasticity a wire possesses which enables it to return to its original form and position, after the applied force has been removed, which has deflected it from its original position, while in the elasticity of torsion we mean the elasticity possessed by a wire which enables it to return to its original form and position after the force has been removed which twisted it upon a central axis.

We use both of these forms of elasticity in our regulating appliances, the elasticity of flexion in our base wires for lateral expansion in both labial and lingual types of appliances, and the elasticity of torsion in the ribbon arch when apical movement of teeth is desired, and in the labial expansion wire where the bucco-lingual tipping of the molar teeth is necessary.

I am pleased that Mr. Williams has explained to us this cuppy-wire, because I have experimented with wires and have found they break quite frequently, and I have never been able to account for this. I think this explanation is possibly one of the most probable causes of this peculiar kind of breaking.

As to the uneven distribution of the platinum and other contents of the alloy Mr. Williams has clearly demonstrated with his Microphotographs upon the screen. First by the heterogenous mix shown by his early slides, and later upon remitting the same ingot and getting a more homogeneous mix as shown in his subsequent slides.

In my experience I found practically the same as he did, that one sample from the same manufacturer would prove entirely different both as to the torsional and the flexible experiments when compared with another sample bought at a subsequent time.

I also found that two wires from the same lot would vary in these tests, and again I have found that one foot of wire, cut in two six-inch pieces, would give a different result when both pieces were heated, and treated alike.

That this is possible on account of the non-uniformity of the mixture of the metals composing the alloy, I think Mr. Williams has made very clear.

It seems to me that the essayist has proven that both the elasticity of flexion, and torsion depend upon the hardness of the wire, and they are both proportionate to the annealing, and tempering of the same.

The essayist has stated, and I believe it is so, that heating to a cherry red does not interfere with the wire to any marked extent. Therefore, the additional tempering to give the wire the most elastic force possible does not deteriorate this material as the heat necessary for retempering to the maximum does not reach anywhere near this cherry red heat. Then it must necessarily follow that a high grade of solder would be better than a low grade one, and any solder ranging between ten and twenty carat could be readily fused and made a perfect union within this range of heat which is lower than that required to bring the wire up to a cherry red, and a high grade solder would certainly not contaminate our gold-platinum material nearly so much as one of a lower carat.

The essayist has shown us that in tempering we gain in both strength and elasticity, when heated in a gas flame and that in the final tempering we would keep from a cherry red heat, but we should heat our material for five minutes on a plate and in a gas flame (such as furnished by a bunsen burner) at about 175° Centigrade, which is about 347° Fahrenheit.

Possibly this heat would only show a blue discoloration on the wire while heat treating.

If this is so, then the heat treatment in the flame and in the presence of air, is better than that of the electric pyrometer furnace for re-establishing the necessary spring

quality of our wires and as this heat is lower than that which is essential for the soldering of our auxilliary springs, it must necessarily be true that our soldered joints cannot be damaged by this process of tempering.

Another point the essayist has given us, is that heating the wire from 5 to 20 minutes increases the spring temper 21% and the tensile strength 28% and if we boil the appliance in pickle (which is usually a solution of sulphuric acid from 10 to 20%) we decrease the spring quality 6%. So in order to avail ourselves of the maximum spring quality we should avoid putting our appliance in acid of any kind or strength. This I think is most remarkable, for one of our members, as early as 1915 told me that he only tempered his pin and tube appliances after soldering by boiling them in a saturated solution of alum. Possibly the alum had no effect other than raising the boiling point of the solution that tempered the appliance. I think this might be a reasonable explanation for his successful method of tempering.

A thought occurs to me at this time, that we might induce some manufacturer to make a copper plate with a small thermostat attached which will regulate the heat to about 347° Fahrenheit, so we can place this upon a tripod sufficiently elevated above the flame of a bunsen burner to give us this necessary 347° of heat for 20 minutes, but no longer, as the essayist says longer heating will decrease the elasticity. Or we might be able to get a copper plate with a well in one corner into which a fusible metal or alloy can be kept at the melting point, which is 347° Fahrenheit, and by keeping the appliance on the hot copper plate for 20 minutes while the alloy in the well is kept at a melting temperature, but no higher.

Possibly the essayist in closing might give us some better ideas on this point.

I wish to thank Mr. Williams for this paper which has indeed been a treat to me, and for his kindness in going over the paper with me this morning, as circumstances which were beyond our control prevented me from seeing the paper before.

Dr. Walter H. Ellis, Buffalo, N. Y.—It is with considerable pleasure and pride that I have listened to this most satisfactory and beautiful address; pleasure for reasons which you can very well realize because you have heard the address, with pride because possibly in some small way I did start him on his path towards research in orthodontia wire, for some years ago while a student in Chemistry at the University, he was an orthodontic patient of mine; and it was either the crudities of our technic of that period, or the method with which I applied them to his case that gave him the thought that there were great opportunities for improvement. I remember his saying, "There is a great field for research work, and I am going to tackle it very shortly." As the years went on and he gained in experience, he did tackle it. His results you have heard today. If I could make a reputation in research work by starting young men on their path, I think I would go out gunning for men and not looking for work myself. It brings to my mind the philosophy of Andrew Carnegie, who said: "I am looking for men. They can do more than I can do." He surrounded himself with men who delivered the goods as he admitted he was unable to do himself.

I will not attempt to discuss his paper from a technical aspect. I can add nothing further; I will say however, that I think he has been a little too modest, if anything, in his presentation, because much of his work is absolutely new and original, more particularly his physical testing apparatus. One is absolutely his own, possibly two, and the others have been modified to the needs of the research as he saw it.

He has also been very modest and very scientific and fair and square, in presenting his comparative tests. However, there is an opportunity for us by using his physical testing apparatus to discover some facts which we are looking for. For example, the particular alloy or whose particular product will give us the properties which we need in our technic. Also, not with any thought to marketing the product, but as a side issue to his research, he worked out formulae, which by comparative tests with others which had been produced, give in my opinion the physical properties which we want in orthodontia. In my hands they have delivered the goods and were superior absolutely, to anything else I had tried. If they do fail in anything, it will not be because he has not been able to produce it but because I have been unable to convey to him what we needed or wanted. He is here not

only to give us information, but possibly to obtain criticism or instruction as to how he can go still farther, delve deeper into the mysteries of metallurgy and produce a product that will be still better. Having his testing apparatus, he can criticise his results and give us what we want.

You have absolutely no conception of the amount of time and financial outlay that has been necessary for him to produce this result. I know of many occasions when he stayed in his laboratory until three or four o'clock in the morning, with no thought at all but for the scientific results.

As a matter of fact, his researches and the results as he has given them to us today, will be the basis or the thesis by which he will receive his Masters Degree in Science, so his work is not only valuable to us but it is important to science at large. I hope that not only will our Board of Censors see that this paper is published in a manner worthy of the subject matter but in a prominent way, that it may be of the most value to us for careful reading and study. I hope further that we will so stimulate him in our discussion, and words of encouragement that he may go on with his researches, and at a later date give us further findings.

Dr. Berry.—I do not feel able to discuss the paper, but I would like to ask one question of Mr. Williams. Many of our spring appliance formations are of such shape that it is impossible to polish or put in presentable appearance unless pickled in acid, and he has told us that this has a deleterious effect; I want to ask him if pickling in cold saturated solution of cyanide of potash would remove the oxid without the deleterious effect.

Mr. Williams.—I have never tested metal pickled in cyanide, but I believe that there would be no ill effects. There is no hydrogen radical present. I will try this out in the near future. I discarded this method of cleansing simply because I thought it to be dangerous.

Dr. Lloyd S. Lourie, Chicago, Ill.—I don't know whether I understood the essayist correctly or not, but it was my understanding that he thought our principal requirement was tensile rather than torsion. I doubt if that is correct, if I understand the definition of tensile correctly. I think possibly he can enlighten me on that. It seems to me that torsion and springiness are more of our requirements than the tensile strength.

Mr. Williams.—Your ligature wire is a soft wire. That wire possesses great torsion, meaning you can take one end, hold it firmly in a vise, take the other end and twist it many more times than you could twist a hardened or spring wire. Your ligature wire possesses greater torsion than your spring wire. It is essential that your wire has torsion in order that it can be manipulated, but if it has no tensile strength, it is almost useless for your purpose.

Dr. Waldron.—We are mistaking your definition of torsion for torsional elasticity.

Dr. Lourie.—I think that clears it. Our requirement is torsional elasticity. That is more important than tensile strength.

Mr. Williams.—Of course, that is only elasticity. It does not matter which way you twist or bend the wire, you will get the same relative elasticity factor. As you will remember from the definition, it does not matter whether the metal is deflected, compressed, twisted, or drawn.

Dr. Waldron.—I might add that the results of my experiments show that the elasticity of torsion and the elasticity of flection run parallel through all the tests.

Mr. Williams.—Yes, they run parallel.

President Abell.—Those are very profitable questions and answers. Are there any more?

Dr. Burke.—Who has written a good textbook on this subject?

Mr. Williams.—I have looked through all of the proceedings of the Royal Society of London, also the Institute of Metals, every text book that I could find in the various large libraries, and so far, have never found any great amount of information on complex platinum, gold alloys. I have never seen a micrograph or any suggestion of this change that

takes place at 172° C. I have heard a great deal about these various "well balanced" alloys, but have never yet seen a cooling curve or equilibrium diagram. It might be interesting to note that in all my micrographs of these complex alloys, I have never found what appeared to be a true eutectic formation. The increased tensile strength that we obtain from tempering, seems to be due to compound formations. There are decided grain boundaries, consequently increased tensile strength.

Dr. Waldron has stated that possibly a tempering appliance with a lead bath in the center would be of great benefit. Steel wire manufacturers have been using this general method for many years, and incidentally, through changes in the crystalline structure at that temperature, sometimes run into a great deal of trouble. Because of their exhaustive research, they are aware of these crystalline changes that cause the wire to become brittle and unworkable. The hardening effect at this temperature is caused, I believe, by the formation of sorbitic trustite.

We have no nomenclature for our various formations. Possibly this will be taken care of in the future, when we know more about our subject. I believe that these tempering changes take place due to the base metal content. Possibly a closer study of brasses or bronzes will give us a better insight into the matter. I don't know whether or not I have grasped your "lead bath" idea, but I do know that this method in the ferrous industries has come into a great deal of criticism. I think that this research will be of some value if you adopt the following procedure: Heat all of your wires to cherry red and pickle if you want to. This will give them greater torsion. Form the arch and attach all of the finger springs. But before you put the appliance into use, place it on an iron plate, on a tripod, over a Bunsen burner and heat for a few minutes at a very low temperature. Do not allow the hot plate to become red. With a little practice you can gauge the time and temperature and you will be astonished at the additional springiness that you can obtain by this method of treatment.

Dr. Burke.—That is just a dull red heat, isn't it?

Mr. Williams.—No, not quite. If you heat to redness, you will find that you have gone too far, and the wire has become annealed and softened. This can be remedied. Heat to cherry red and start tempering again.

I have tested and retested the same piece of wire a good many times and under the different methods of heat treatment, they came back to approximately their former point. The crystalline structure did not seem to be permanently affected.

Dr. Waldron.—I hate to rise again but I am afraid that Mr. Williams misunderstood me when I spoke of this copper plate with a well in it. I didn't mean a lead bath or any fusible metal, I meant a small well attached to this plate, possibly at one corner where we could have a fusible metal that would become liquid at three hundred and fifty degrees and we could absorb that just on a tripod at a certain distance from the burner or lower the burner in accordance until we get the metal and that is the heat at which we lay the wire on the plate. It is just as a gauge and not to contaminate the metal. I did speak of the pyrometer which would possibly be better and we could easily arrange one of those very cheaply to attach to this same copper plate.

Dr. Locke.—Isn't there some way we could have this paper of Mr. Williams printed separately and mailed to the members of this Society? I would like to have a separate copy of that.

President Abell.—That matter will be brought up at the next meeting of the Board of Censors this afternoon and see what we can do.

Dr. Locke.—Regarding cyanide potassium, I have used that for years and there is no danger. I have used it for eight or ten years.

Dr. Kelsey,—I wanted to just ask the essayist this: I know that in the micrographs the platinum was visible as platinum. I wanted to ask him if there is any molecular mixing of those metals, if it is purely mechanical, and also if the other metals in there, copper and other metals in the alloy which do not appear definitely as the platinum does, have any molecular or if there is any molecular composition or union between those and the gold.

Mr. Williams.—If there is a molecular union, compounds are formed. There might be compounds formed in our metal during the tempering stages, in fact, our micrographs would indicate compounds or eutectic points. However, these alloys are simply solid solutions. We can get examples of almost pure platinum segregation, but when we remove these areas for chemical analysis, we always find the other metals present, but with a preponderance of platinum.

Dr. C. R. Baker, Evanston, Ill.—I would like to ask the essayist about cooling the wire in air after heating. Do you leave the wire exposed entirely to the air of the room, or is it advisable to put it in a container that has a lid to make it cool more slowly?

Mr. Williams.—I have heard a great deal about covering these wires during cooling, but my experiments did not show any additional benefits. In some industrial processes, they cover metal during annealing or cooling, but they usually do this in order to make them more workable. We are trying to arrive at an opposite effect.

Dr. John V. Mershon, Philadelphia, Pa.—One question—Whether he has kept in mind the secretions of the mouth and the effect they may have on the metals after being in the mouth a long while. He needn't answer that.

Dr. Barnes.—I think we have listened to a masterly paper and certainly a scientific one. I would like to ask the essayist if he has considered the fact in his annealing that we might have a difference in temperature and an uneven annealing by laying our apparatus upon brass plates and expecting to get the same temperature or the same union effect in that metal which is in contact with the copper plate, the same effect on the base wire as we would upon extension springs which might be a sixteenth of an inch, eighth or a quarter of an inch away from the copper plate. Those are the conditions we have to deal with in many of our appliances.

Again another question. I would like to know whether he has considered the effect upon metals at or near the point of soldering. There must be a change in many of these alloys through the effects of soldering, because I have known of breakages in the appliances just at the junction of the solder line and the apparatus. I don't know whether that is due to faulty metal or faulty technic or the wrong soldering. I think that would have much to do with the functioning of the metal in our work.

One other question. In dealing with pickling of a metal, do you consider putting the metal cold into acid and boiling it produces this hydrogen effect and the loss of strength the same as you would in heating the metal and dropping it into cold acid? Does that account for loss of strength?

Mr. Williams.—The dropping of the hot metal into acid has two effects, namely, changing the crystalline structure, and absorption of hydrogen. By altering this crystalline structure, you lose about 20 per cent of the elasticity of the metal, by absorption of hydrogen, you lose about 7 per cent. I have not undertaken any experiments with soldered joints. If the zinc or tin in a solder does not permeate the wire and weaken its crystalline structure, I can see no reason for its weakening the wire.

As to the tempering question, I believe that there would be sufficient radiation from the top of the hot plate to pretty well temper all parts of an appliance.

In answer to Dr. Mershon's question, I believe that the secretions of the mouth, over a long period of time, might have some effect on the physical properties of a wire. If weakly acid, or even basic, there might be hydrogen absorption. However, I do not believe this to be the case, inasmuch as it is my impression, that wires stiffen while in the mouth. This would lead us to believe that hydrogen is occluded rather than absorbed. I take for granted that these wires that stiffen in the mouth, have not been strained beyond their elastic limit.

Dr. Young.—I would like to ask just one question. Probably Mr. Williams hasn't taken this phase up. If a wire is soldered on to another, say a light wire is soldered on to a heavier wire, and then sharply bent over, we will say and not annealed or treated in any way, will that tend to make the wire more brittle or more elastic?

Mr. Williams.—Both conditions might occur. The harder the wire, the more elastic it will be, and of course, the bending or cold working adds additional hardness. If you

annealed and plunged all the wires before bending, there should be no great danger of fracturing during this operation. Of course, I take for granted that the whole appliance is to be tempered later. If you are going to use these wires without further heat treatment, just as they come from the manufacturer, your own experience will have to be your guide.

I have found what I consider to be a safety limit of torsion. That is, a wire reading on my instrument, in an annealed condition, 16 or better.

Dr. Hawley.—Just as a curious corroboration of what we have heard today in annealing wires, when I have been in a hurry with delicate wires, I have found that where I didn't raise the wires to a red heat I got just a little better result. I noticed that when they were raised just in the heat where they commenced to oxidize, and that is quite a long ways from red heat, and then thinking to hurry the matter I would take them out and cool them in the air as quickly as I could and take some pumice stone in my fingers, moisten and rub over it, not take any time to put it in an acid. To my great surprise I got just as good or better results. That corroborates exactly the scientific finding. Very often in our regular work we stumble upon things that we can't realize are true and yet finally they are proven by scientific investigation. I think that is interesting to impress upon the mind.

Dr. Conroy.—I would like to ask the essayist do we gain any of that elasticity by holding these wires on a brush wheel on the lathe for any length of time and generating heat that way? Do we gain any strength?

Mr. Williams.—Yes, if you buff well with a leather buff, you can approach this tempering heat. I believe that Dr. Hoffman made this suggestion several years ago. I have always known that buffing stiffened the wire, but only recently knew the reason for this change.

Dr. Hoffman.—It is absolutely impossible for me to discuss this paper. The very humble contribution that I have made to it has just been from practical experience, and I am sure that it would be very ungracious on my part if I didn't rise to say these few words of congratulation to Mr. Williams.

Dr. Hugh G. Tanzey, Kansas City, Mo.—I would just like to say this word, that I am not particularly interested in metallurgy any more than we all are in a practical way, but I think that I have never heard a paper that interested me and entertained me so much regardless of the subject as this one presented by Mr. Williams this morning, and I think he being a young man and after what Dr. Ellis has said to us, it is a nice thing to say something to that effect to a young man. He read something in the beginning of his paper that I would like to have him repeat in regard to the maximum of characteristics that the orthodontist would like in these wires, and it led me to believe that there was a possibility of presenting an already tempered wire or a wire that is already annealed and tempered that we could expect the most of and treat it regardlessly, that is, we could go ahead and solder it and immerse it or not as we like and we would still expect those characteristics. I can't quite repeat what he said but I think he will remember it.

Mr. Williams.—I referred to a wire, which when annealed, would have a maximum elasticity with a safety limit of torsion. By safety limit of torsion, I mean that it should not break under a reasonable amout of bending. If the wires break, in spite of the annealing, there is faulty structure or the wire possesses too much tensile and not enough torsion.

President Abell.—If there are no more questions, I will ask Mr. Williams if he has anything further to say to us.

Dr. Waldon.—I move a rising vote of thanks to Mr. Williams.

The motion was carried unanimously.

President Abell.—We will have now the remaining four case reports that we feel we must put on at this time or they can't be given. Dr. Waldron will show us what he has for us.

PRESIDENT'S ADDRESS*

By Burt Abell, D.D.S., Toledo, Ohio

I APPEAR before you today, believing I stand before men who, by a more intimate knowledge of the policy that has shaped the history of our Society, and by greater advantages of heredity and culture, could better serve you. I have been conscious this whole year through of a responsibility that I would gladly meet did I but know how. I consider you have conferred upon me the highest honor in your power—one I had rather receive at your hands than a similar one from any other body of men with whom I've ever been associated. Banquets and loving cups are well in their place, but this conveys not only an expression of your confidence and friendship, but the opportunity to render *to you* the best there is in *me*. To give you a service born of love and friendship, something more than the mechanical movements of a chairman.

I find as I've traveled together with you this year, that you have become to me, not Doctor So-and-So of such-and-such a place, but Joe and Jake and Ben and Bob and Walter and John, with a community of interest and depth of sympathy I'd never known among you before—with an intimacy that is most precious and will abide as a blessed memory to the end of life's journey.

My purpose at the beginning was to go over the literature of our Society and give you actual quotations from this one and that one to show you, if possible, what was really the *soul* of our profession—That as "Straws show which way the wind blows" I might gather together a fabric which might portray to you the dominating thought among us. To do this I found would make too bulky a paper, but I found everywhere, expressed either one way or another, the thought of *Service*. I trust that as in the past, so now in this meeting, and in the future, this thought may be uppermost in our minds and hearts and may abide with us—that, as we listen to the papers and enter into the discussions, we may seek better equipment for service, to our patients and our professional brethren—that here, as we consider in our business sessions plans and policies, our deliberations may lead us where, from former fallacies of practice, we shall arrive at a place of larger, fuller service to each other, to our patients and to our brethren of allied professions.

My hope is that "Service" may be the keynote of this meeting; that differences of opinion, not constructive, may disappear; that personal preferences and prejudices may vanish into thin air before the nobility of its appeal.

*Read before the American Society of Orthodontists, Chicago, Ill., April 9, 10, 11, 1923.

If, in my zeal for better service, I encroach upon personal prerogatives, I crave your leniency. If I have failed to sense our needs, I count on you to remedy that defect; and if, be the impelling motive what it may, proposals are brought before you which may seem premature or undesirable, I depend upon *your* sound judgment and fine sense of the eternal fitness of things to outline a straight course and formulate a policy that shall relieve us of many of the embarrassments of the past, and permit us to give a more fearless consideration to the aims for which we exist as a Society.

Thanks, hearty and deep, are due the members of the Executive Board. No one, who has not served in this capacity, can know the sacrifice of time and strength that has been so freely and efficiently given. Secretary-Treasurers, both past and present, have served you to the limit. If we find, as we shall before we are through our business, places where they have seemed to fail, attribute such to our system rather than to the spirit of the men.

It is with gratitude we acknowledge the hearty and prompt response given to our appeal by those who contribute to our program by papers, clinics, case reports, etc. We assure them of our closest attention and most hearty appreciation.

We would be ingrates indeed if we did not render grateful recognition to our local committee of arrangements who have so willingly shouldered, not only their own duties, but some others that might rightfully belong to other committees.

The first matter I am presenting to you is approached with great hesitancy; one long considered, yet one so vital to the individual member and to the Society that it must be left with you for your consideration. No president so far has mentioned it. Whether he sidestepped it or because his conviction was that it did not pertain to Society matters, cannot be determined.

I refer to the professional man's Avocation: This subject becomes pertinent when we consider no Society or body can be better than the individuals composing it. A boy scout master states that the test of character of an individual is what he does with his leisure time.

Charles Hughes says, "A man has to live with himself and he should see to it that he always has good company."

The specialist, continuing along the line of a single objective, will lose his sense of proportion unless he stops to realize that life is greater than his work; that the great service he aims to render humanity must be the product of his life, his character, the man himself, balanced and developed evenly along the threefold avenues of body, mind and spirit. The consideration is that these three cannot be divorced; that the inter-relation is so vital that neglect or excessive tax on one reflects not only on all but has a corresponding effect on each. Effort, long sustained in any one of these, is exhaustive, and diversification is imperative, but whether practiced in the realm of the one field or made to include all three it must be *constructive.*

This diversification we call our leisure—and the way we employ this will determine our efficiency in our chosen line. To illustrate: The busy

orthodontist, brain fagged with the day's work, seeks recreation in study along some other line. He forgets his troubles and is more or less refreshed by change of interest. I contend that it would be far better to leave all study behind and play golf if so inclined or any other physical exercise, but let him *overdo* that and the overtired body takes its toll from the next day's regular work.

To carry the matter farther—If the Saturday afternoon golfer carries this relaxation over into the Sabbath and it be done ever so well to the building up of body and mind, it's done at the expense of his *spiritual* nature. I'll agree that on Monday he may be a better orthodontist by a Saturday and Sunday attention to the golf course, but I maintain that if, with his soul attuned to the Infinite and a conscience void of offense, he spends his Sabbath in an effort to build up his spiritual and moral nature, an enlarged vision of all that goes to make a life would make him a better orthodontist, and other things being equal, by the same token, he should be a better golfer.

You'll surely have your own opinions about what I've just said, but there are no two ways about what I'm now going to say, and I maintain that no one of us can gainsay it. The real orthodontist becomes the friend of his little patients and leaves the indelible stamp of what he *is* upon them. How careful then should he be that the *real* man, the one he and he alone is developing from day to day, shall be clean, well balanced and one finely equipped for the largest service.

Doctor Rogers, in an article read before the Pacific Coast Society of Orthodontists, on "Co-ordinating Natural and Artificial Methods of Treatment," a copy of which he kindly sent me, has this to say *in re* the influence of the orthodontist upon the character of his little patients: "He is but an indifferent orthodontist who fails to qualify as a teacher to the young life daily under his influence. The very fact that one may teach a child to accomplish some physical development through individual effort, may develop a trait of character that in the future may result in the child being far more of a man or woman than otherwise might have been the case."

The teaching done purposely is not the only kind to which the child is subject at our hands. Their keen little minds are quick to gather ideas from chance expressions that may change their whole moral and spiritual outlook on life—these same expressions of ours being but the result of our own mental, moral and physical balance or imbalance, determined by the use we make of our leisure hours.

The keynote of the age is "Prevention." We orthodontists thought we had tuned our harps to it when ten or twelve years ago we welcomed the call of Doctor Bogue, of blessed memory, Dr. Barnes and others, to recognize that after about eight years of age the jaws anterior to the first permanent molar underwent very slight change. Disciples arose here and there and preached their little bit until the call became insistent and we began employing preventative measures in 3-4-5 year olds, but the limits of our definition did not extend back of that age. A few, a very few, began to question

if there was not a cause far, far back of that age. In the records of the fifteenth annual meeting at Pittsburgh, I find Doctor Weinberger, concluding his article on "Prenatal Influences on Malrelation of the Dental Arches at Birth," saying this: "We have only begun to search for the causes of malrelation of the dental arches, and that also holds true for the malocclusion of the teeth. For the next step in the study of orthodontia we must learn what influences bring about certain specific malformations during ontogenetic development. Orthodontia is not and cannot longer be considered mere mechanical treatment. Our profession is entitled to the scientific standing it has been given. To further this we must overcome the idea of its being purely mechanical and place it in the scientific rank and position which it deserves."

Strong as is the case against appliances, we'll never be able to eliminate them from our practice for there'll always be the "didn't knows" and the "wait awhiles," many of them recruits to the great army of the "too lates." All honor to those who have helped to simplify these appliances, decrease their bulk, and increase their efficiency; still more to men like Doctor Rogers and other trainers of muscles, and the psychologists that have helped to eliminate these "crutches" early in the day.

As we scan our programs of recent years we see here an endocrinologist and there a pediatrician. We ask by what happy accident do these stars arise on our horizon and cast their helpful beams on our particular field, and we find it is in response to this same query for the causes that lie at the very foundation of our profession. And when they appear they assail us with indisputable facts that often malrelations in the jaws and in the deciduous teeth, at least, are due to early intrauterine influences, hereditary, pathological or mechanical. They attack the teachings of our dental and medical books concerning the dental arch at birth. They prove to us that the endocrin imbalance of the mother has an endocrinodontic effect upon the child, both intrauterine and also early extrauterine, through nursing; that the interference of the synchronism of the endocrin organs and the sympathetic nervous system, is responsible for many facial and occlusal deformities, and cite us to the correction of certain types of malocclusion by feeding the child thyroid extract, and cap it all with an italicised statement that, "*This is a practice needing the immediate and most careful investigation by orthodontists.*" We listen and in astonishment say, "If these things occur in the green tree, what shall be done in the dry?" and search our souls to see if the call is not ringing loud and clear for some one to turn his undivided attention to this untried field of preventative orthodontia, and say, like some Isaiah of old, "Here am I, send me," and we stand ready to follow as willing and eager disciples.

Up to a very few years ago our orthodontic literature contained but two papers dealing with this subject. Today the need is for one who, from the mass of accumulated data, can correlate causes and practice, and with prophetic eye visualize for us how we may render the largest service, not only to our present age, but to myriads yet unborn. 'Twill be a brave man

indeed who, from the cloistered shelter of an ethical practice, shall preach the gospel of healthful living, and right dress; of eugenic marriage and responsible parentage; that his patients yet unborn may secure that birthright of physical symmetry reflected in perfect face and teeth, that should be the heritage of every child.

Brethren, we're learning many things; we're digging down to basic facts; data is accumulating. What are we going to do with it?

We have arrived at the point in our investigation and practice where the mouth has become to us an index of general metabolism and we cannot treat what we find there empirically if we are to render our best service to our patients. The research and records of our own profession so far have not met our complete need. Closer affiliation with all that's said and done in both the dental and medical professions, is necessary if we are to comprehend in our development as a profession all that is our privilege and duty.

In passing, it may not be amiss to question as to whether some of our own findings at least may not be just as much needed by these other allied professions. Failure so to ally ourselves lays us open to the charge of carelessness, incompetence or bigotry. For the purpose of the better gaining and disseminating pertinent, valuable and scientific data, I want to recommend the establishing of an Inter-relations Commission whose duties shall be the conferring with similar commissions or committees in allied societies for the interchange of papers, clinics, case and research reports, literature, etc., of common interest to both or all and who shall be constituted a standing committee within our own Society, advisory, in its function, to our program and research committees. This committee should very properly, in conjunction with other orthodontic societies, seek to promote higher ideals for the establishing and conducting of our schools of orthodontics that they may be saved from any reputation of commercialism and function along the highest professional plane.

Let our Executive Committee carefully consider the peculiar fitness of certain of our members by education, inclination and interest to superintend and promote the interests of such a committee, and let one be chosen as its head and *continued in office* so long as he functions properly, and retired only for good and sufficient reasons. Only thus can we hope for persistent, progressive performance in the realm of any committee's duties. Our present method of appointing chairmen from year to year logically must eventuate in results more or less desultory, to say the least. The incentive of a proper perspective is lacking.

This committee may very properly assume the duties of our former Educational Committee, and its report from year to year should enlarge our horizon and deepen our professional foundations.

While careless or unadvised tampering with the constitution of our Society should not be countenanced, incorporating this matter in some carefully considered, definitely outlined form in our fundamental laws of practice, must surely register progress.

Doctor Lischer, in a recent letter, suggested among other things the

establishing of a Fellowship, membership in which should be based on scientific achievement. I hope he will have more to say about this in his discussion. This Inter-relations Committee may very properly have much to do with establishing and fostering such a Fellowship, or may resolve itself into a Fellowship section.

Doctor Dewey pointed out to us in his president's address of last year that the American Society of Orthodontists was formed for the advancement of Orthodontia as a science and a specialty, and called our attention to the apparent condition of affairs in which the latter object is paramount in our consideration at present. Many of us never were and never could be scientists in the true meaning of the word, but we are rendering acceptable service to our patients as *specialists,* and we are dependent upon our more learned brethren for the scientific data so necessary for us all. If the plan I have to suggest later is adopted we shall all contribute to the effective working of such a Committee or Fellowship of our scientifically inclined brethren.

In the spirit in which Lincoln said, "With malice toward none; with charity for all; with firmness in the right, as God gives us to see the right," let us approach the next matter in hand. Let us take counsel of past mistakes and practices, and with heart and mind responsive to the needs of our own membership, of our confreres and of our patients, outline a policy and maintain a practice with this as our point of departure:

I. Let us substitute for Article 1, Section 5, of the By-laws, the following: All papers read before this Society shall become its property and shall be delivered to the secretary immediately after reading and shall be left in his hands and shall not be subject to revision.

That stenographic reports of addresses and discussions sent to their authors for correction, shall be returned to the secretary within ten days or be subject to elimination from our records at the pleasure of the Executive Board, and that such revisions or corrections shall not include anything whatever by additions or eliminations that shall in any way prejudice other discussions from the floor.

II. That the compiling and editing of our proceedings shall be in the hands of one responsible alone to the Society and not to any commercial house, and that he be ex-officio, a member of the Interrelations Committee, if we see fit to appoint one.

III. That the maintenance of our self-respect demands that Article II, Section I, of our By-laws, be amended to read $25.00 wherever it says $10.00; that our dues may cover all costs of the activities of the Society, and that we should ask favors of no outside interests for the purpose of *saving ourselves expense;* that we should freely grant "permission to print", where by so doing we can confer the greatest educational benefit upon our own members and our associates in allied professions, and where we can give the widest publicity to our contributors, which is their just due.

What this may mean in plain figures may be stated thus:

We have 194 members which at $25.00 ea. would be		$4850.00
Suppose we lose a membership of 34 (which is almost unthinkable) making		850.00
We'd still have left on which to do business		4000.00
Expenses of one year are approximately	$1500.00	
Last year's cost of printing of proceedings was about	1200.00	2700.00
Leaving for research, etc.		1300.00

It has been pointed out that if the amendment to raise the dues to a figure where they were adequate for our needs, were objected to we would be without funds to print this year's proceedings.

I trust this proposal may meet your *unanimous* approval. If not, however, may I call your attention to the fact that during war times, for patriotic purposes, we purchased a $1000.00 Liberty Bond which we still hold. As the motive for its purchase need be no longer a consideration, and as we are not in the business of loaning money, this can be liquidated and the amount used, if necessary, to print our proceedings. Also, Article II, Section 2, of our By-Laws, permits an annual assessment to meet the incidental expenses of the Society.

Heretofore it has been the practice of this Society to grant permission to print our proceedings to one or more commercially conducted journals for an "honorarium" (?) of a bound volume to each member. May I quote from E. H. Johnson: "It is universally felt to be an indignity to a profession for a professional man to give prominence to his pecuniary claims. It is essentially hypocritical to set up as a professional man while ruled by motives suitable to other callings," and by the same token how shall a Society composed of professional men conduct its affairs with an ideal less noble?

Enough extra copies of our proceedings should be printed each year to replace those lost by accident or otherwise, and stored in a *permanent* place in charge of a librarian who could be of great service to members by making an index of all papers, etc., and keeping it up to date. The only attempt at this was Weinberger's Review of Eighteen Years of the American Society read before us in 1919 at St. Louis, since which time no revision has been made so far as I know. Our younger members especially would greatly appreciate such an index and access to our literature. At present a drayload or so of material not pertaining in any way to the duties of his office is dumped on each succeeding Secretary-Treasurer. This is often stored in damp basements and no one knows what is available. It would seem to be entirely within the province of the Executive Board to provide for this could they but know the will of the Society in the matter.

In conclusion may I say that I am anxious that each one in this, one of the finest bodies of men the sun ever shone on, shall see to it that he shall secure for himself the fullest and most complete development of soul, body, and mind that the Architect of his life planned he should have, and that the professional expression of that life is dependent, more than most of us recognize, upon the disposition of our leisure time.

Also, may I ask you to carefully consider the fact that the plummet of our investigation and reasoning has not fathomed the depths where lie the real causes of malrelations of teeth and arches, and never will till some seer shall arise who shall marshal all data in both our own and allied professions.

My hope is that you will see fit to institute a constructive program whereby funds may be available for not alone research along this line but any other necessary for our advancement, and also for the maintenance of all legitimate activities of the society along unquestioned professional lines; that under-graduate and post-graduate education may receive at your hands

the consideration they deserve. In the body of this paper you will notice that I have outlined no plan concerning this latter subject, feeling I could do no more than suggest that whatever is done should strictly adhere to the professional leaving constructive suggestions to those more qualified to lead.

I feel that this meeting will not be at all outstanding in its helpfulness unless our suggestions and discussions crystallize into action, and that rests with you.

CASE REPORTS

REPORT OF CONGENITALLY MISSING TEETH AND SUPERNUMERARY TEETH*

By Dr. Charles R. Baker, D.D.S., Evanston, Ill.

I WISH to report a series of 262 cases in which radiograms covered every region of the mouth anterior to the permanent second molar, in which the permanent teeth had not erupted. In some cases, the permanent second molar region was also included. No record was made of third molars. This report is, therefore, equivalent to a record based upon full mouth radiograms, except where the second molars were not considered on account of the age of the patient, and with a possibility of additional supernumerary teeth being present that were not discovered. The number of teeth congenitally missing in an individual ranged from one to thirteen.

TEETH CONGENITALLY MISSING

Upper

Right		**Left**
10	Lateral incisor	7
2	First premolar	2
11	Second premolar	11
1	Second molar	1
24		21

Lower

Right		**Left**
1	Central incisor	2
1	Lateral incisor	1
23	Second premolar	22
1	Second molar	1
26		26

Upper teeth missing	45	
Lower teeth missing	52	
	—	97
Supernumerary teeth (upper)		10
Total discrepancies in 262 cases		107

*Read before the American Society of Orthodontists, Chicago, Ill., April 24, 25, 26, 1922.

A REPORT OF TWO CASES*

By W. H. Ellis, Buffalo, N. Y.

THE first is that of a boy with a congenital bilateral cleft of palate and lip, the palatal cleft being unusually wide. He was successfully operated on for closure of the cleft by Dr. V. P. Blair, of St. Louis.

Orthodontic treatment was commenced at five years of age, Fig. 1 showing arch at that time. Fig. 2 shows expansion resulting from eight months' treatment. Fig. 3 illustrates the appliance designed for the case.

Fig. 1.

Fig. 2.

Fig. 3.

This is but a partial report, the case being still under treatment and is shown at this time merely as a record of the possibilities for arch development in a cleft palate case, through orthodontic stimulation.

The second case is one of root movement. In the model (Fig. 4) (and the first radiogram, Fig. 5) of the case before treatment, the canine may be observed to be in a slightly mesial position in relation to the lateral.

*Read before the American Society of Orthodontists, Chicago, Ill., April 24-26, 1922.

Figs. 7, 8 and 9, taken at intervals during treatment, will show how the lateral root, particularly its apex, has been moved mesially and out of its position lingual to the cuspid, thus allowing the cuspid to move into place.

There was an interval of four months between Figs. 6 and 7 and between

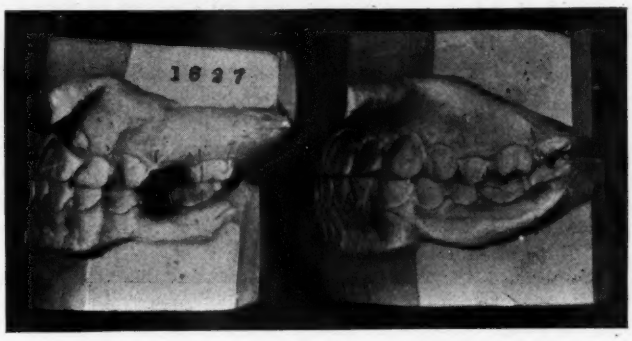
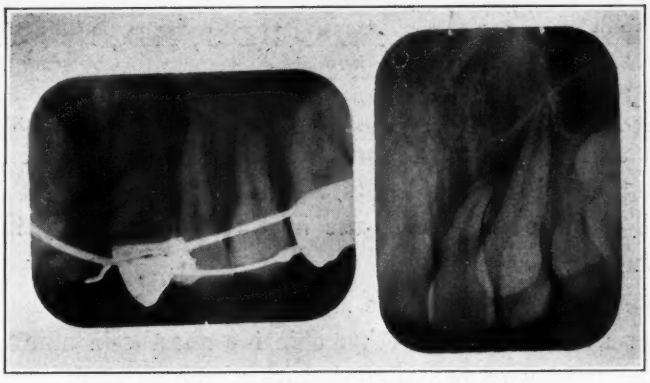
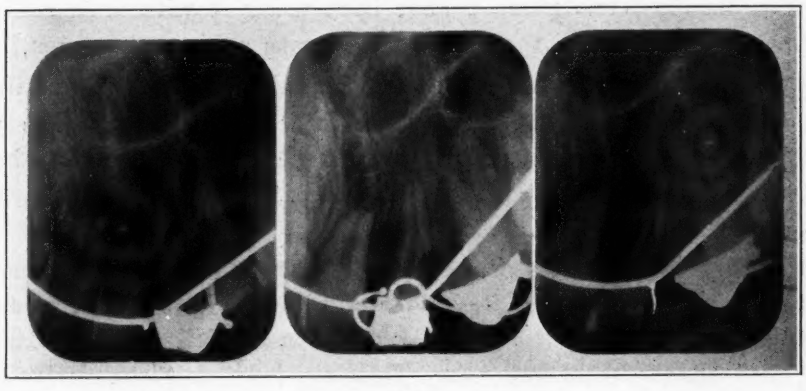


Fig. 4.



6 5



9 8 7

8 and 9, the patient not being treated during these intervals. The lateral incisor was tipped by means of a finger spring acting from the arch wire of an angle pin and tube appliance, to a vertical tube attached to the lateral.

The patient was fifteen years of age at the completion of treatment, when the model as shown in Fig. 7 was made.

DEPARTMENT OF
ORAL SURGERY AND SURGICAL ORTHODONTIA

Under Editorial Supervision of

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ETHYL CHLORIDE AS A GENERAL ANESTHETIC IN DENTISTRY*

By Themistocles J. Mavrocordato, D.D.S., M.D., New York City

THE most popular general anesthetics used by our profession today are nitrous oxide and oxygen, somnoform, and ethyl chloride. Of those three, the first is very popular in the United States; the second, somewhat used; while the last one, ethyl chloride is more in use in Europe, especially in France, England, and Germany.

A few years ago, following the surgical clinic of the School of Dentistry of Paris, I was attracted by the ethyl chloride anesthesia administered by Dr. Camus. The simplicity of the administration, the excellent anesthetic results, and the very few, if any after effects, induced me to the study and use of this agent. For the past two years I have been using it with such success, that I have practically given up the use of my nitrous oxide and oxygen.

Ethyl chloride is a colorless, mobile liquid, exceedingly volatile, has a sweetish taste, and a fragrant etherial odor. It is inflammable, has a boiling point 12/50°C, specific gravity 92 at zero degrees, and is liable to be decomposed if exposed to air and strong sunlight. It is readily soluble in alcohol and ether, and very slightly in water.

The anesthetic properties of ethyl chloride were found out by Flourens in 1848; and the following year, Heyfelder administered the vapor as anesthetic for surgical purposes; but its use was abandoned until the year 1894, when Carlson, and, in the following year, Thiesing, both dentists, revived its use. In the years 1897 and 1898, Ludwig and Lotheisen made a scientific study of the drug, and from that year, the more accurate knowledge of its properties and its physiological action, together with the improvement of its manufacture made ethyl chloride quite popular. In 1902, it was introduced to England where it almost replaced nitrous oxide.

*Read before the Section of Oral Surgery of the First District Dental Society, April 18, 1923.

Preparation: Ethyl chloride is prepared by distilling together ethyl alcohol, 5 parts, sulphuric acid, 2 parts, and sodium chloride, 12 parts; or, by passing dry hydrogen chloride into absolute alcohol. It is supplied mainly in automatic closing tubes of different sizes for local anesthesia and in sealed tubes or ampules for use in various inhalers for general anesthesia.

Physiological action: Respiratory organs. It is not irritating to the air passages. Respiration is increased somewhat in depth but not in frequency. According to Embley, the integrity of the respiratory mechanism in ethyl chloride narcosis is dependent upon the maintenance of the blood pressure.

Circulatory system: Ethyl chloride is taken by the blood very rapidly and eliminated with the same rapidity. The blood serum takes up only a slight amount. A greater amount is, however, fixed by the blood corpuscles. On account of its slight solubility in the blood serum, and its very loose solution with it, the vapor is at once given off from the blood, and the person is awakened promptly, unless an excess of the gas is administered. The recent experiments of Dr. L. Camus and M. Nicloux have shown the following facts. The rapidity with which the blood fixes ethyl chloride coincides with the rapid and prompt appearance of the symptoms of anesthesia. The quantity of ethyl chloride in the blood during the third or surgical stage of anesthesia, oscillates between 30 to 200 milligrams per 100 c.c. The moment that the corneal reflex disappears, the arterial blood contains approximately 25 milligrams per hundred c.c. In less than a minute after the removal of the inhaler, the quantity of the gas in the arterial blood diminishes half; and in two minutes, the same decrease is found in the venous blood.

The length of the administration of the gas, the degree of its saturation, and the general condition of the organism have great influence on the rapidity of its elimination. All authorities agree, that in full surgical narcosis with ethyl chloride a slight fall of blood pressure is noted. Buxton states that the slight flushing of the face, due to dilatation of the peripheral vessels, may account in part for any fall of blood pressure that takes place.

Kidneys: No deleterious effect on normal kidneys; rarely the urine contains traces of albumin, symptom disappearing the following days.

According to Hewit, ethyl chloride may prove fatal in two distinct ways. First, by overdose or ethyl chloride toxemia; and second, by intercurrent respiratory embarrassment or asphyxia.

Stages of anesthesia: Although some divide it in three, I believe there are four short, but distinct, stages.

First stage: or stage of analgesia, is characterized by diminishing of the frequency of the pulse which is nearly always accelerated before the administration, owing to the mental excitement of the patient, deepening of the respiration, onset of moderate muscular tension, the sensation of pain is completely abolished; although the patient is still conscious and the hearing perfectly preserved. This stage begins after two or three breaths of the anesthetic, and lasts over thirty seconds after the removal of the inhaler. This is the stage before the excitement or stertor appears and is sufficient for very short operations; opening of abscesses, drilling in pulp chambers, etc.

Second stage: or stage of excitement—This stage lasts only a few seconds and is characterized by slight and involuntary movements of the legs and arms; symptom often entirely absent; but always present in nervous and alcoholic patients.

Third stage: or stage of complete or surgical anesthesia—is characterized by moderate muscular relaxation, complete loss of reaction to external stimuli, regular and deep respiration, disappearance of conjunctival and corneal reflexes. The eyeballs are fixed and rolling slightly upwards, the pupils are widely dilated, the face slightly flushed, due to the dilatation of the peripheral vessels. The patient appears as if quietly asleep. This stage lasts, according to the kind of patient, from one and a half to two minutes after the removal of the mask; in fact, after the removal of the inhaler, the anesthesia is deepened owing to the absorption of ethyl chloride from the lower air passages.

Fourth stage: This stage is again one of analgesia. It lasts from thirty to forty seconds during which time no sensation is felt. The patient conveys the impression of being wide awake. The first sense to return is hearing, and the next is sight. The end of the fourth stage is recognized by the manifestation of pain and the movements of the patient.

The rapidity with which the signs of ethyl chloride anesthesia come about, depends upon the susceptibility of the patient, the rate and depth of breathing, the rate at which the ethyl chloride is vaporized. If the administration is continued long after the third stage, the bulb is affected as in all other anesthetics, and may cause secession of respiration, followed by arrest of the heart, and death.

Signs of overdose: Abnormally dilated pupil, very great pallor, intermittent respiration or gasping for breath.

Elimination of the gas takes place mostly through the lungs, especially in brief narcosis. The system is entirely free from the drug in about five or ten minutes after the anesthesia.

After effects: They vary according to the patient, his preparation and the way of administration. Generally speaking, if all preparatory measures are taken, and the length of administration is moderate, no after effects whatever occur. In some cases the patient has a certain dazed feeling, which disappears soon with the elimination of the gas.

In very nervous and sensitive patients, in cases of prolonged administration and overanesthetization, or careless preparation of the patient, as full stomach, tight corsets, etc. we may have headache, nausea and even vomiting. Nausea, when it occurs, seldom lasts over ten or fifteen minutes. Erotic thoughts and dreams may occur, although are less frequent than in nitrous oxide narcosis.

Safety of ethyl chloride: There is much difference of opinion, and I believe the risk of administering this anesthetic has been much exaggerated. Generally they class it between ether and nitrous oxide.

Dr. Hadfield of London in his book "Practical Anesthetics 1923" says: "I have never seen a death from the use of ethyl chloride in skilled hands." It is probably little, if any, more dangerous than nitrous oxide. It is true,

that its action is more rapid, and the danger signs, if they ever supervene, do so quickly and are not as obvious as with the gas, thus necessitating most careful watching of the patient.

Dr. Luke after a long experience with this anesthetic states it is undoubtedly an excellent anesthetic agent, but the anesthetist must know its indications and have full self control. Personally, I never had a fatal accident although I am using it every day.

Dr. DeFord in his book on "General Anaesthetics in Dentistry," although giving preference to the use of somnoform, states, "I consider ethyl chloride in careful hands, one of the safest of anesthetics."

Ross, Cantlie, and Mortinier consider it preferable to nitrous oxide for short operations.

Henenkekht, based on his experience of 3,000 cases, concludes that ethyl chloride is the least dangerous narcotic which we possess at present, not excepting nitrous oxide for anesthesia of short duration.

Mortality: According to statistics made from both long and short administrations, the mortality is 1 in 17,000, and I agree with DeFord, that all those mortalities have been due to carelessness, improper or too prolonged administration.

Soullier and Leons report 8,417 cases without any adverse symptoms. Seitz reports 1 death in 16,000 cases recorded by him, and this occurred in a case in which ethyl chloride was contraindicated.

McCarthy asserts that it is the safest of all anesthetics, except nitrous oxide, and that the death rate may be placed as one in many hundred thousands. Later, in 1906, after an experience of 2,000 cases says: "In my practice, I have not seen either asphyxia or syncop during its administration."

Without trying to diminish the value or safety of nitrous oxide and oxygen, I think it is interesting to state that Dr. Gwathmey in his book on anesthesia, 1914 states; "The probable death rate of nitrous oxide and oxygen for surgical cases, is one in ten thousand." This rate being fixed from the number of cases reported to the author.

Indications and contraindications: Up to the present time, the administration of ethyl chloride for long major operations proved not very successful, and it seems to be generally accepted that it is wiser to restrict its use to brief minor operations for which it is particularly suitable. There is no contraindication as to the age or sex, although ethyl chloride seems to be the anesthetic par excellence for very young children.

According to Hadfield, ethyl chloride is taken well by patients of all ages, and seems especially suitable for the very young and the very old. Many claim that there is really no contraindication; though I think, in order to be on the safe side, we must consider advanced respiratory affections or obstructions of the respiratory passages, organic heart lesions, and severe kidney diseases as contraindicated.

Advantages and disadvantages: I believe that the only disadvantage of ethyl chloride, as a general anesthetic in our profession, is that the anesthetist must have a complete knowledge of the subject. He must have full confidence

in himself and the anesthetic, and not use it indiscriminately and carelessly, as at times is done with nitrous oxide. We must remember that ignorance, inexperience and carelessness on the part of the anesthetists are responsible for more deaths than the action of all anesthetics combined.

Advantages over nitrous oxide: Although we cannot claim as yet any advantage over nitrous oxide and oxygen as to safety, still, there are some secondary advantages of great importance.

First, the beauty of its action. Second, the simplicity of technic in administration. Third, the small size of the inhaler, making it neat and portable. Fourth, period of excitement very short and moderate, if present. Fifth, no liability to cyanosis. Sixth, no swelling of the tongue and mucous membrane. Seventh, the average available anesthesia, in single administration, is longer than the average anesthesia of nitrous oxide alone.

Advantages over somnoform: Somnoform is an anesthetic mixture of ethyl chloride, 60 per cent, methyl chloride, 35 per cent, and ethyl bromide, 5 per cent. Introduced by Dr. G. Rolland, dean of the dental school of Bordeaux, in 1899. From that time it was extensively used in dentistry, instead of ethyl chloride; this being due to force of habit more than anything else. It is only during the past few years that after long experimental work along this line, ethyl chloride began replacing somnoform with great rapidity, being today recognized as safer, and with less after-effects than somnoform. Today it is well-known and accepted even by the most enthusiastic advocates of somnoform, that this preparation is not a chemical combination, but a mechanical mixture. This being so, methyl chloride entering into the combination of 35 per cent, is more volatile than ethyl chloride, but has insufficient anesthetic power even to produce anesthesia in very small animals. Ethyl bromide, 5 per cent in combination, has a boiling point 39 to 40 degrees and so it is less volatile than ethyl chloride. It is a cardiac and respiratory depressant, with a death rate when used alone 1 in 5,000. It is easily decomposed, and is slowly eliminated by the blood, being the last to leave the system in somnoform anesthesia, thus increasing the after-effects.

Administration: Ethyl chloride can be given by the open, and closed methods; the latter, being most commonly used in our profession. Dozens of inhalers have been introduced; as the Simplex, the Ideal, Clover's Modified, Davis, Decolland's, Stark's, etc. but all that is required is a bag connected with a suitable face piece, and some method of introducing the anesthetic into the bag. All those things are represented by Dr. Camus's inhaler that I am using. The inhaler is composed of an elastic face piece (a), a metallic cylindrical receiver or chamber (b), where the ethyl chloride is introduced and vaporized, and a very light bag (c), used for confining the anesthetic vapors. A thick rubber tubing (d) is tightly attached to the receiver and its use is to receive the tube or ampule (e) which fits tightly into it to avoid leakage. The dose in this method, as in all methods of re-breathing, is one or two c.c. for children, and three or four for adults. In exceptional cases five or six c.c. for strong alcoholics or heavy smokers.

Technic of Administration: No absolute rule can be formulated to cover

all cases in administering anesthetics, and although I find it very hard to explain how I administer it, I will try to describe a case of an average patient of good health, average build and habits.

Before starting with the actual procedure, I must put emphasis on the preliminary preparation of the office, and the mental and physical preparation of the patient, for I believe that half the success depends upon the proper preparation.

The anesthetic or operating room must be very quiet and soothing to the eye; a competent assistant is of very great help, as most of the preparation of the patient is left to her. When the operation has to be performed on the

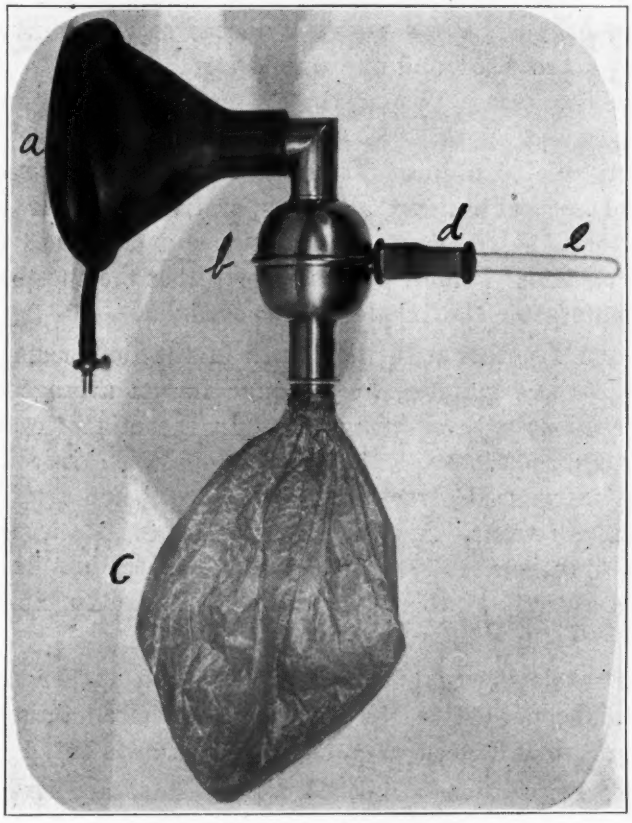

Fig. 1.—Dr. Camus' inhaler.

patient's first visit, as is usually the case with the specializing oral surgeons or exodontists, a rest or preparatory room is indispensable.

If the operator is not specializing as in my case, I find it very practical if the case is not pressing and painful, to examine the patient in one sitting, examine his heart and pulse, have an x-ray taken, make the diagnosis, decide on the operation and have him come back another time with an empty or nearly empty stomach.

The patient properly prepared being seated in the chair, I introduce the mouth prop, and with the ethyl chloride tube in place but not fractured, I adjust the inhaler on the patient's face, and instruct him to breath regularly. After two or three breaths, at the end of expiration, so as to have the bag full,

I remove the inhaler, fracture the tube and readjust it on the face, keeping it loosely over it for the first two breaths, so allowing some entrance of air. The gas is not unpleasant and the patient takes it easily. Then I press the face piece tighter on the face, excluding all air possible. The patient is now breathing pure ethyl chloride with the air which was exhaled into the bag. At the end of the third inhalation or in about 15 seconds from the application of the inhaler, the patient is on the border line between the stage of analgesia and that of excitement. If we want to make use of the analgesia, as I will state later, it is at this point that we withdraw the inhaler and proceed with the operation, the patient having no sensation of pain for about thirty seconds. One or two more inhalations, and we reach the stage of excitement, when present, the patient moves his arms and legs involuntarily. By this time the eyes are fixed and the pupils start to dilate. This stage lasts only a few seconds. After two or three breaths, a soft stertor or purring sound is heard, caused by the relaxation of the soft palate. This is accompanied by widely dilated pupils with the eyeballs rolling upwards, absence of conjunctival and corneal reflexes and comparative muscular relaxation. As soon as the stertor is heard, I remove the inhaler and proceed with the operation without losing time. It must be remembered that the anesthesia is deepened for a few moments after the inhaler is removed.

The anesthesia, together with the return of the fourth stage or analgesia, lasts from two to three minutes, time enough for an average operation, such as multiple extractions with curetting, etc. In exceptional cases, if there are signs of returning consciousness, before the operation is completed, a new ampule can be introduced, fractured, and the inhaler reapplied when the same phenomena will recur. A good rule is never to give a second dose after the patient has once been fully anesthetized, until the pupils have definitely commenced to contract. If this rule be followed, rigidly, no trouble will be encountered.

During the whole period of anesthetization, except for a few encouraging sentences to the patient in the beginning of the administration, absolute quietness must reign, if I need anything from the assistant, I ask it by signs.

As soon as the operation is finished, the assistant applies pieces of gauze, properly prepared, on the wounds, to avoid swallowing of the blood. After the completion of the operation, I ask the patient who is in the analgesia stage, or at the end of it, how he feels. I remove the pieces of gauze, and then the prop, and when I see that the patient is sufficiently aroused, I ask him to expectorate and free his mouth of the blood present. Two unpleasant things may happen, if we lean the patient to expectorate, before he is sufficiently awake. First, he is liable to spit everywhere; and second, it predisposes him to nausea. After the patient rinses his mouth, I usually place the chair horizontally, and let him rest for 5 or 10 minutes before leaving the office, so making sure that all the gas is eliminated from his system.

When can we use with advantage ethyl chloride, anesthesia and analgesia?

Analgesia: Bearing in mind that this stage lasts 30 to 40 seconds, that it is not dangerous and has no after-effects, we can use it with great advantage

in many short but painful conditions that we are called upon to treat. Such cases are: Entering the pulp chamber to expose a pulp, or for drainage in case of acute paracementitis from a dead pulp, completing the grinding of teeth for crowning, finishing a painful cavity for fillings, lancing acute alveolar abscesses, cutting a portion of gingival tissue in unerupted impacted third molars, simple and easy extractions when curetting is not necessary, etc.

Anesthesia: With the exception of badly impacted teeth, deeply-seated, broken roots, necrotic conditions, antrum cases, cysts and tumors where conduction and infiltration anesthesias prove to be ideal, we can use ethyl chloride in all other cases where we seldom need more than two or three minutes for the operation.

In conclusion: Without trying to induce the use of this agent to any of you, I am confident that to those who are properly qualified, who have a thorough knowledge of the subject, who have above all, self-control and full confidence in themselves, this anesthetic may prove of great advantage if used on the right cases and in the proper way.

DEPARTMENT OF
DENTAL AND ORAL RADIOGRAPHY

Edited By
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RATIONAL RADIODONTIC TECHNIC (INTRAORAL)

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I. INTRODUCTORY

THE following is a brief summary of a simplified and systematized technic for making intraoral radiographs:

In order to get a "good radiograph"—that is, a correct radiographic image—the positions of (1) the *head,* (2) the *film* in the mouth, and (3) the *x-ray tube* must all be correct.

II. POSITION OF HEAD

When the film is placed in the mouth for the *upper teeth,* the patient practically always tips the head back too far. The operator must see to it that the head is tipped back down, until the occluso-incisal plane of the upper teeth, from the distal of the first molar forward, is horizontal; or, expressed

Fig. 1*A*.

Fig. 1*B*.

Fig. 1*A*.—The film packet has just been placed in the mouth for an upper tooth. (It is held in place with a film holder.) The head is tipped back too far for the upper teeth. Instruct the patient to "put your chin down."

Fig. 1*B*.—*Correct* position of the head for the upper teeth.

in terms of facial landmarks, until a line drawn from the *tragus* of the ear to the *ala* of the nose is horizontal. See Figs. 1-A and 1-B.

When the film is placed in the mouth for the *lower teeth,* the patient practically always tips the head too far down. The operator must see to it that the head is tipped back up, until the occluso-incisal plane of the upper teeth, from the distal of the first molar forward, is horizontal; or, expressed

Fig. 2*A*.

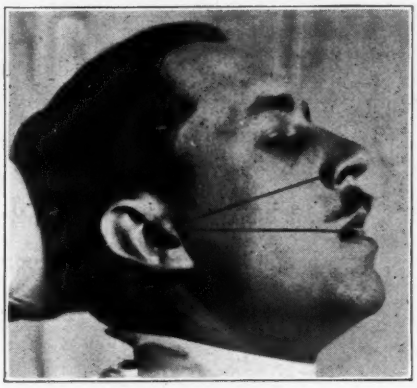


Fig. 2*B*.

Fig. 2*A*.—The film packet has just been placed in the mouth for the lower incisors. The head is tipped down too far. Instruct the patient to "Raise your chin."

Fig. 2*B*.—*Correct* position of the head for the lower teeth. (Figs. 1*A*, 1*B*, 2*A*, and 2*B* are from the book "Radiodontia" and are reproduced here by courtesy of the Dental Items of Interest Publishing Co.)

Fig. 3.—The Simpson *occlusal plane finder* is in the mouth, the head has been moved until the *finder* registers level and the *external occlusal plane indicator* has been applied to the temple. The *finder* may now be laid aside and the head positioned by means of the lines of the *indicator*.

in terms of facial landmarks, until a line drawn from the *tragus* to the *corner of the mouth* is horizontal. See Figs. 2-A and 2-B.

When the head is tipped back too far for the upper anterior teeth, the radiographic image is elongated.

When the head is not tipped back far enough for the lower anterior teeth, we fail to get the root ends and periapical tissues and there may be some elongation.

Briefly stated the *rule* for placing the head in the correct position is to "have the occlusal plane horizontal." It is more exact perhaps to say occluso-incisal plane, but the phrase occlusal plane is the one in common use. In practice, the operator may accomplish this, (1) by looking at the teeth, (2) by facial landmark lines (as just described), or (3) by the use of the Simpson *occlusal plane finder* and indicator. See Fig. 3.

The facial landmark lines may be imagined or actually drawn on the face.

The occlusal plane finder is a piece of flat metal equipped with a two-way, or a circular, spirit level. It is placed in the mouth, as far back as the distal of the first molar, then the head moved until the spirit level registers level. Then the *external occlusal plane indicator,* a piece of gummed cloth with two lines on it, is attached to the temple. See Fig. 3. The upper line represents the occlusal plane of the upper teeth, the lower line the occlusal plane of the lower teeth (with the mouth opened).

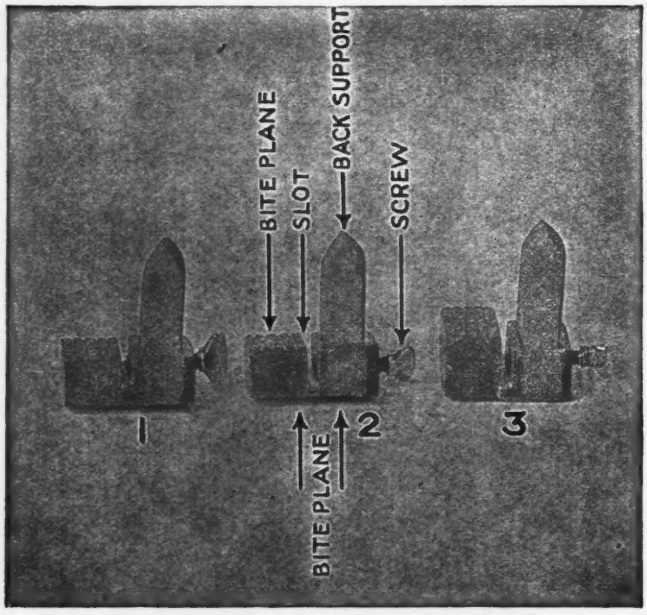


Fig. 4.—Set of *universal film holders,* showing different slot lengths and the flexible rubber back support.

The wider the mouth is opened the farther the occlusal plane of the lower teeth departs from the plane of the upper teeth. Thus, in order that the line from the tragus to the corner of the mouth, or the lower line of the external occlusal plane indicator, may be correct, the mouth should always be opened to substantially the same distance when radiographing the lower teeth. To accomplish this, it is best to use filmholders. See Fig. 4.

III. HOLDING THE FILM IN THE MOUTH

Filmholders, with variable slot lengths and a flexible back support for the films, should be used in all parts of the mouth. (Fig. 4.)

Place the film-packet in the holder with the nonsensitive side facing the rubber back support and tighten screw.

Just before placing the film-packet in the mouth, it may be bent some-

what to conform to the mouth. By bending a part of the film-packet, deliberately, where bending is unavoidable, the operator may prevent bending of the entire surface of the film.

Thus, for the upper incisor region, the film packet may be bent back rather abruptly on either side throughout the length of the packet. (This

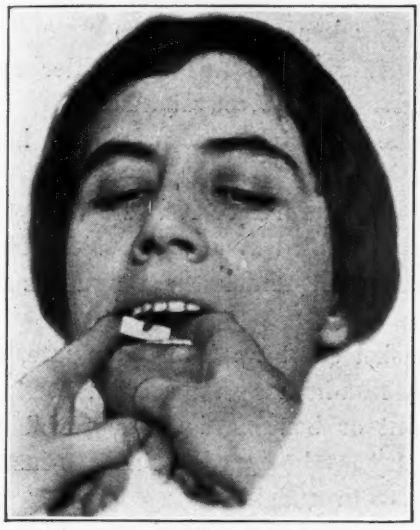


Fig. 5*A*.

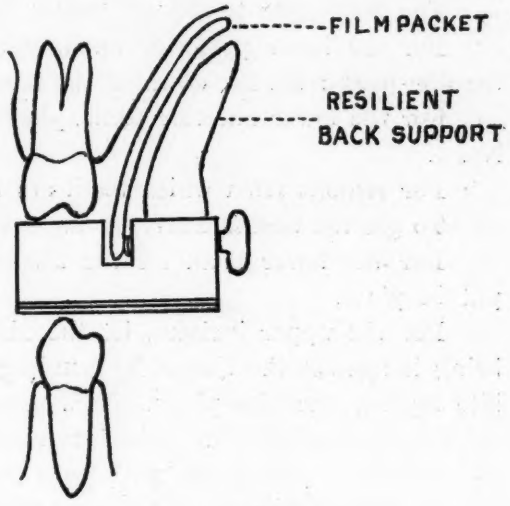


Fig. 5*B*.

Fig. 5*A*.—Film holder with film packet in place in the upper premolar region. The patient has been instructed to "close" on the bite planes of the holder.
(The operator has not yet removed his fingers from the mouth; the width of the holder keeps the patient from biting the fingers.)

Fig. 5*B*.—A sketch showing how the film holders function. The rubber back support bends to conform to the mouth, holding the films snugly in place.

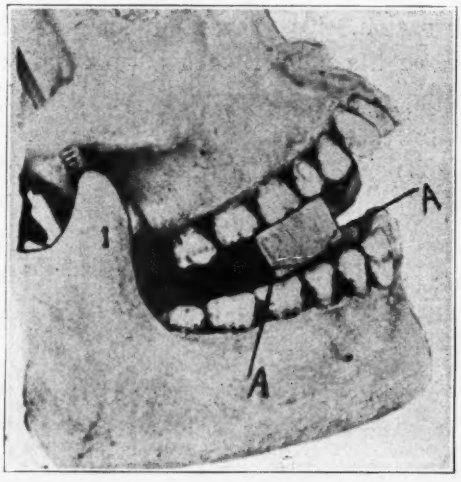


Fig. 6.—Unless the film holders are beveled as illustrated by the dotted lines *A*, they may tip (downward in front) when the patient bites on them. The holders are beveled both in front and back so they may be used on either right or left sides.

bending for this region is best done before the packet is placed in the holder.) For the upper canine region, the upper anterior corner may be bent. For the upper premolar region, the upper anterior corner may be bent. And for the upper molar region, both upper anterior and posterior corners may be "relieved," that is, bent very slightly. For the lower incisor region, the film

packet may be bent the same as for the upper incisor. For the lower canine region, the lower anterior corner may be bent freely. For the lower premolar region, the lower anterior corner may be bent freely including a good area of the packet and almost including the upper anterior corner. For the lower molar region, both the anterior and posterior corners may be "relieved" slightly.

For the upper teeth, use holder No. 1. (Sometimes No. 2.)

For the lower posterior teeth, use holder No. 1 unless the holder forces the film-packet too far down in the mouth, when No. 2 may be used.

For the lower anterior teeth, placing the film-packet longways, use holder No. 3.

For regions from which teeth are missing, use holder No. 3.

To get the tissues above an impacted lower third molar, use holder No. 3.

For the lower teeth let the film-packet slant under the tongue as it is put in place.

For the upper incisors, let the film-packet slant up into the palate, then bring it against the tissues by bending the film-holder so the lower teeth can bite against the bite plane. This movement or bending is made possible by the flexibility of the rubber back support. It may be expedient also to instruct the patient to "reach out with your lower teeth and bite."

Gagging is less likely to occur when film-holders are used than when the patient holds the film with the fingers or thumb. If, however, it does occur, use novesthene troches or anesthesin calcidin tablets; also have patient hold the breath while making the exposure.

The film-holders are beveled, as illustrated by the dotted lines A in Fig. 6, to prevent tipping. There is very little likelihood of tipping except for the upper third molar region. To prevent it, keep the holder as far forward as possible, and still have the rubber back support afford enough support to prevent excessive bending of the film, and bevel the holder more if necessary to suit the individual operator.

Some advantages of using film-holders over having the patient hold the films are: (1) Slipping (movement) of the film-packet is less likely to occur. (2) Gagging is less likely to occur. (3) There is less likelihood of having the film-packet too high, or too low, or tipped. (4) Time is saved. This, because the technic for using holders is easier and because fewer re-takes are necessary.

Compared to other holders, the ones illustrated in Fig. 4 have the great advantage of being really universal. All of the films for Figs. 18 and 19 were held with holders.

IV. DETERMINING THE ANGLE OF THE X-RAYS

The angle of the x-rays may be varied in two planes, namely the vertical plane and the horizontal plane. See Figs. 7-A, 7-B and 8.

Adjustment of the *horizontal (plane) angle* is easier and simpler than the determination of the *vertical (plane) angle.*

The vertical angle is also known as the "vertico-horizontal angle" because the variations are in a vertico-horizontal manner. And the horizontal

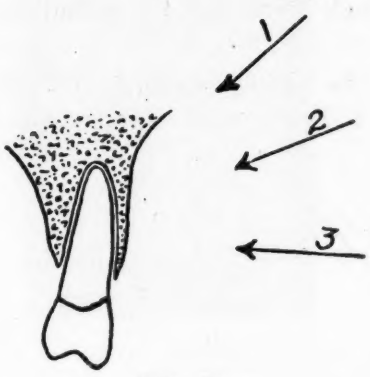


Fig. 7A.

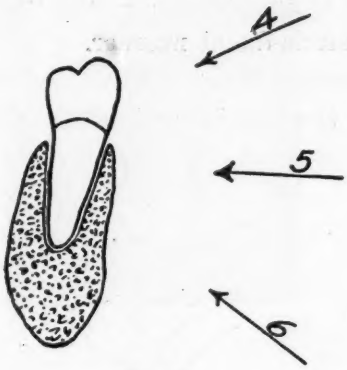
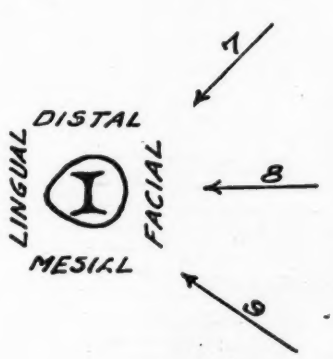


Fig. 7B.

Figs. 7*A* and 7*B*.—The arrows 1 to 6 inclusive show variations of the *vertical angle.* Fig. 7*A* is a sketch of a section through the upper jaw; Fig. 7*B*, a sketch of a section through the lower jaw.



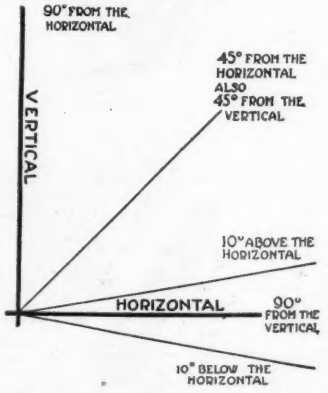


Fig. 8.—Sketch of occlusal view of tooth. Arrows 7 to 9 inclusive illustrate variations of the *horizontal angle.*

Fig. 9.—The purpose of this drawing is simply to remind those who have forgotten what is meant by such phrases as "ten degrees above the horizontal," etc.

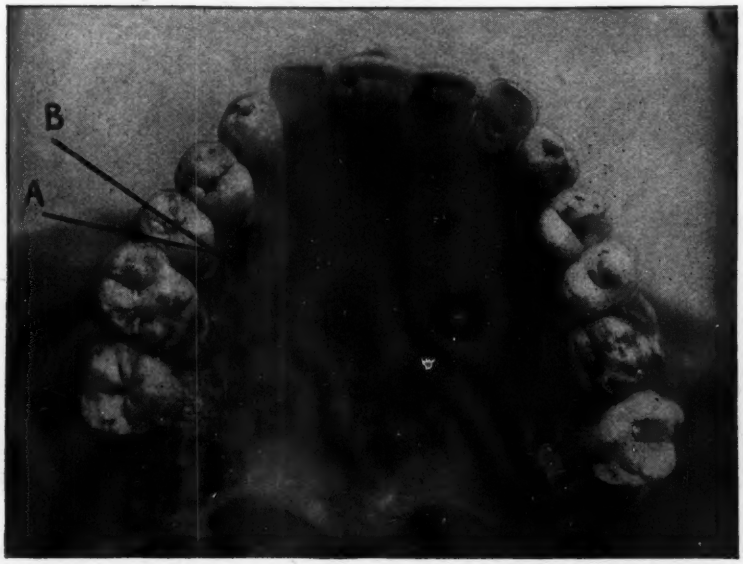
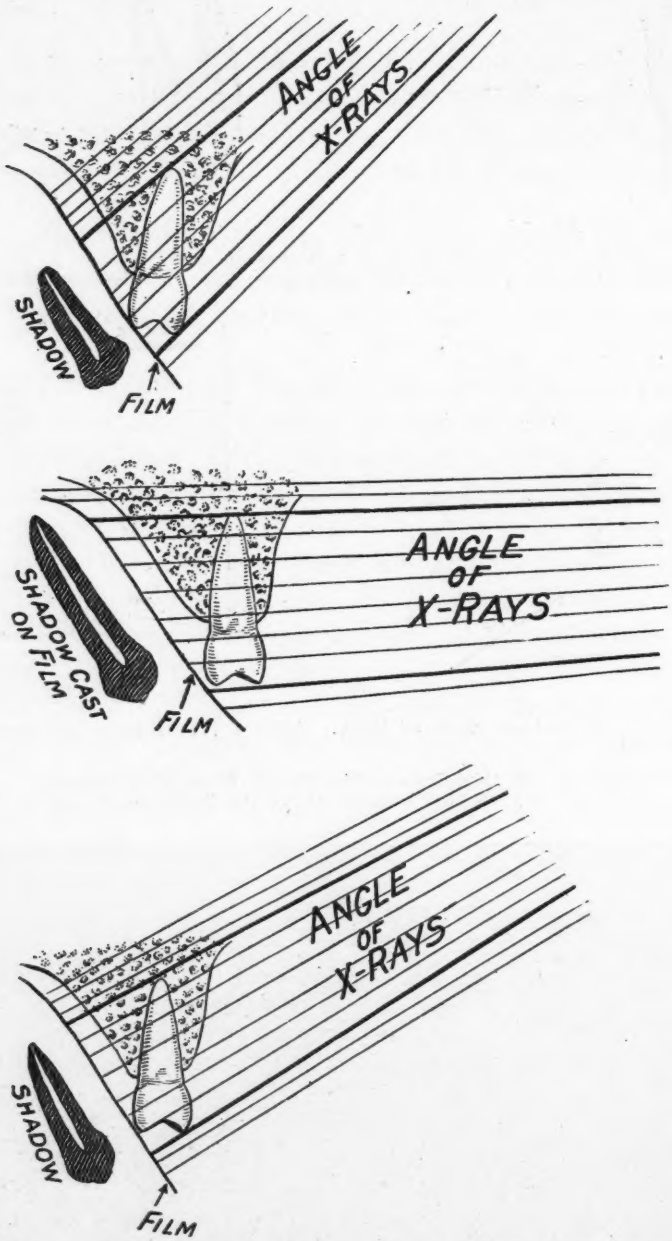


Fig. 10.—Line *B*: Correct horizontal angle. Line *A*: Incorrect horizontal angle—unless such angle be used for some specific purpose. (From Raper's Elementary and Radiodontic Technic, Courtesy of Dental Items of Interest Publishing Co.)

angle is also known as the "mesio-distal angle" because the variations are in a mesio-distal manner.

Ordinarily the *horizontal angle* should be simply straight through the tooth from facial to lingual (like line B in Fig. 10) or, to express the same



Figs. 11, 12, and 13.—These cuts illustrate how variation of the vertical angle causes variation of the radiographic image case on the film. Fig. 12 shows elongation. Fig. 11 shows foreshortening. Fig. 13 is the correct angle to prevent elongation or foreshortening. (Figures 10, 11, 12, and 13 are from the book "Elementary and Dental Radiography.")

idea as Simpson aptly expresses it, "parallel with the proximal surfaces."

The determination of the *vertical angle* is more difficult. (See Figs. 11 to 15 inclusive.) It should be measured by means of an *angle meter.*

TECHNIC FOR USING THE ANGLE METER: (1) Set the meter. (Take hold of

Fig. 14.

Fig. 15.

Figs. 14 and 15.—Incorrect vertical angle may result in failure to show (radiographically) bone destruction, due to abscess or pyorrhea. For example Figs. 14 and 15 are of the same case. Fig. 14 was made at an incorrect vertical angle and fails to show the periapical bone destruction. Fig. 15 was made at the correct vertical angle and shows the area of bone destruction. (From the book "Electro-Radiographic Diagnosis.")

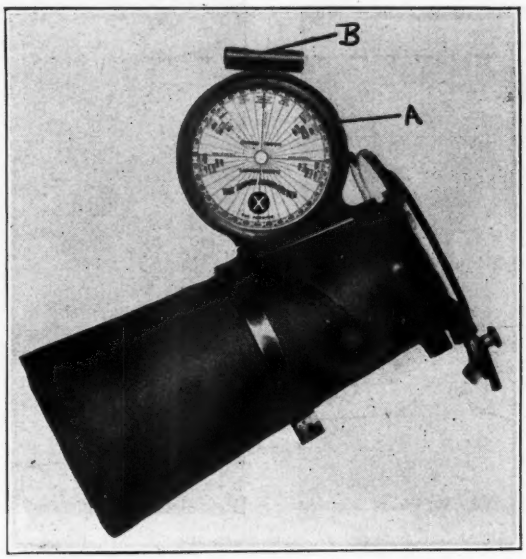


Fig. 16*A*.—*Angle meter* on cone. The meter illustrated here is one of the first crude working models made.

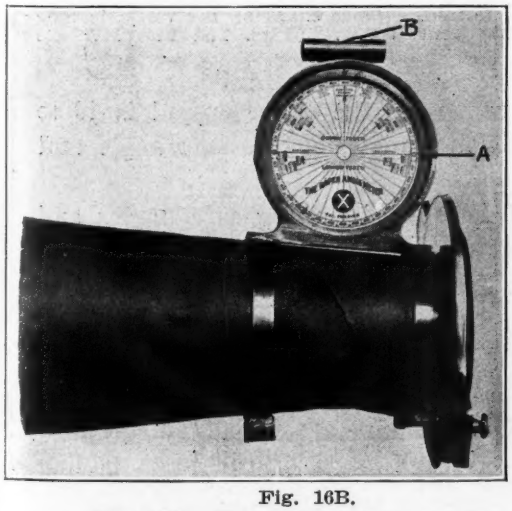


Fig. 16B.

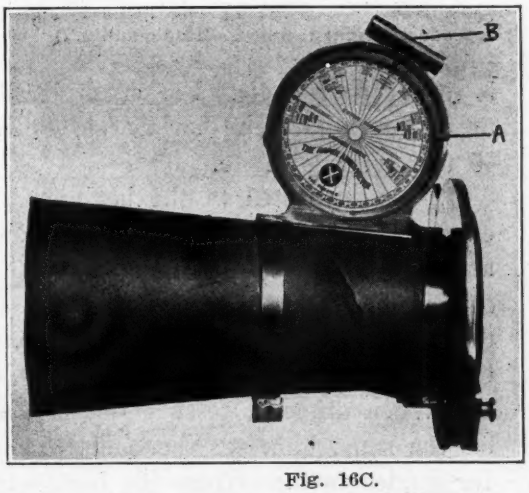


Fig. 16C.

Fig. 16*B*.—The meter is now *set* for an angle of thirty degrees above the horizontal, the average angle for upper molars.

Fig. 16*C*.—The cone is now tipped, until the spirit level of the angle meter registers level; that is to say until the cone is tipped to an angle of thirty degrees above the horizontal.

the spirit level (B) and move the dial until the indicator (A) points to the desired angle. Read the meter dial only on the side of the vertical line nearest the x-ray tube.) See Figs. 16-A and 16-B.

(2) Tip the tube until the spirit level registers center. The *vertical angle* is now correct. See Fig. 16-C.

(3) Make the necessary adjustment of x-ray apparatus and the patient's head to give the correct *horizontal angle* and to *centralize the central ray.* See Figs. 17-A and 17-B. Do this *without changing the vertical angle.**

MORE ABOUT SETTING THE ANGLE METER: The angle meter may be set for a *safe, average* or *fine* angle.

It will be noticed on the angle meter dial that the various teeth have a *range* of degrees. The angle farthest from the horizontal is the *safe angle,* the angle nearest the horizontal is the *fine angle* and the intermediate angle

Fig. 17A.

Fig. 17B.

Fig. 17*A*.—The vertical angle is correct here for the upper molars, but the *central ray* has not yet been *centralized.*

Fig. 17*B*.—The central ray has now been centralized, *without* changing the vertical angle of thirty degrees above. The line *C* indicates the central ray. (Figs. 17*A* and 17*B* are reproduced from the book "Radiodontia.")

is the *average angle.* For example, the range for the upper cuspid is 40 to 50 degrees above the horizontal; 40 is the fine angle, 50 the safe angle and 45 the average angle.

It is suggested to the beginner that he start by using safe angles and change to average angles if he is troubled with foreshortening. The average angle will be found correct in over 95 per cent of cases if the head position is correct and the film is held in the mouth correctly. The fine angles are ones to be used occasionally by the particularly discriminating operator. See the Chart of Angles.

When different teeth calling for different angles are to be radiographed on the same film, set the meter for the average angle of the tooth calling for angles farthest from the horizontal.

*Some x-ray machines are so made that there is no danger of altering the vertical angle after it is set. With others the operator must be careful or he may inadvertently change the vertical angle by the adjustment of other joints on the apparatus.

CHART OF ANGLES

All of the information given in this chart, except the last column and the footnotes, is conveniently indicated on the Dial of the Raper Angle Meter.

Tooth	*Range*	*Permissible extension of Range*	*Safe Angle*	**AVERAGE ANGLE**	*Fine Angle*	*Remarks*
UPPER TEETH						
Upper Incisors	35–45 Above	——	45 Above	**40 Above**	35 Above	The operator must be careful or he will have the patient's head tipped back too far.
Upper Cuspids	40–50 Above	——	50 Above	**45 Above**	40 Above	——
Upper Bicuspids	25–35 Above	35–40 Above	40 Above	**30 Above**	25 Above	The extended range is practically never needed for the second bicuspid and seldom for the first. When the vault is quite flat and the roots are long, it may be needed to get the root ends of the first bicuspid.
Upper Molars	25–35 Above	25–20 Above	35 Above	**30 Above**	25–20 Above	Use extended range when the vault is very high or the crowns of the teeth are tipped to the lingual.
LOWER TEETH						
Lower Incisors	10–20 Below	——	20 Below	**15 Below**	10 Below	The operator must be careful or he will not have the patient's head tipped back far enough.
Lower Cuspids	15–25 Below	——	25 Below	**20 Below**	15 Below	——
Lower First Bicuspids	10–20 Below	——	20 Below	**15 Below**	10 Below	——
Lower Second Bicuspids	5–15 Below	——	15 Below	**10 Below**	5 Below	——
Lower Molars	0–10 Below	0–5 Above	10 Below	**5 Below**	0–5 Above	Use the extended range when the teeth are tipped to the lingual.
SPECIAL CONSIDERATIONS						
When the crowns of Lower Molars tip far to lingual				**5 Above**		Second and Third Molars are more likely to tip toward the lingual than First Molars.
When the crowns of Upper Molars tip far to the lingual, or the vault is very high				**20 Above**		
When the film is placed flat, i. e., parallel with the occlusal plane (which should be horizontal for the upper teeth)	60–70 Above			**65 Above**		
Extra-oral	65–75 Above			**70 Above**		

When the operator wishes to include two, or more, teeth, calling for different (vertico-horizontal) **ranges**, on the same film, he may select a compromise angle between them, or, better as a rule for routine practice, he may select the **average angle of the tooth calling for the angle farthest removed from the horizontal**. This causes the least amount of foreshortening of the tooth calling for an angle nearest the horizontal, consistent with about a 95+% certainty of getting the apical region of the tooth calling for the angle farthest from the horizontal.

It is sometimes difficult to get a clear outline of the small roots of upper first bicuspids. Deliberate foreshortening by using an angle of 40–45 degrees above will usually "bring out" the roots more clearly. Foreshortening of the roots of any tooth, notably the upper front teeth, brings out the root outlines clearer, but does so at a sacrifice of diagnostic quality.

Chart A.—Chart of Angles. (From book "Radiodontia," by Courtesy of Dental Items of Interest Publishing Co.)

The operator may, if he wishes, set the meter entirely by the drawings on the dial. The nearer he sets the meter to the end of the root of the tooth being radiographed the surer he is to get the end of the root. About the middle of the tooth is the average angle and the fine angle is at the crown end.

Some advantages of using an angle meter, to measure the vertical angle, are: (1) Angle determination is made much easier, and this saves time and energy. (2) Errors can be quickly and definitely corrected. (3) Gross error is prevented. (4) Angles can be duplicated. (5) Accuracy replaces "guess work" and uncertainty.

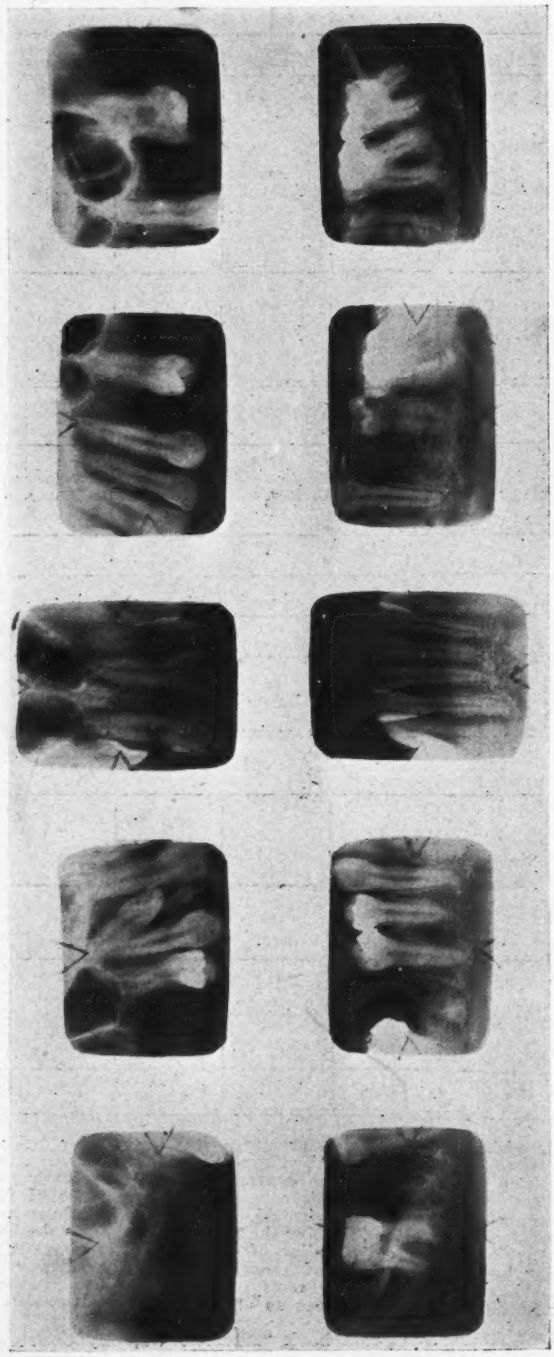


Fig. 18.—The ten-negative whole-mouth survey. See "Technic Chart." Film holders were used to hold all the films. Holder No. 3 was used for the upper left molar region from which the teeth are missing.

TEN-FILM SURVEY—TECHNIC CHART

Teeth	*Vertical Angle* *	*Horizontal Angle*	*Filmholder*	*Position of Film*	*Time of Exposure Factors* Film-Target Distance, 18 In. Milliamperage, 20 ma. Spark-Gap Back-Up, 4½ In. (57,000 Volts)	*Time of Exposure Factors* Film-Target Distance, 8 In. Milliamperage, 10 ma. Spark-Gap Back-Up, 3 In. (45,000 Volts)	*Time of Exposure Factors* Film-Target Distance ..... Milliamperage, ... Spark-Gap Back-Up ..... (To be filled in by individual operator).
Upper Incisors	45 Above	Straight through between Central Incisors.	Film packet longways. Holder No. 1 or No. 2, preferably No. 1.	Center of film packet between Central Incisors.	About 8 seconds	About 7 seconds	
Upper Cuspid and Bicuspids (also including the Lateral Incisor).	45 Above	Straight through Cuspid or a little disto-lingually.	Film packet crossways. Holder No. 1 or No. 2, preferably No. 1. (Some prefer to place the packet longways).	Mesial (front) edge of packet center of Central Incisor, or a little farther mesially. (Make certain to get the lateral).	About 7 seconds	About 6 seconds	
Upper Molars	30 (+) Above	Parallel with distal surface of First Molar.	Film packet crossways. Holder No. 1 or No. 2—preferably No. 1.	Mesial edge of packet about center of Second Bicuspid, or a little farther distally. (Make certain to get the First Molar).	About 10 seconds	About 7½ or 8 seconds	
Lower Incisors	20 Below	Straight through between Central Incisors.	Film packet longways. Holder No. 3.	Center of packet between Central Incisors.	About 7 seconds	About 6 seconds	
Lower Cuspid and Bicuspids.	20 (+) Below	Straight through Cuspid or a little disto-lingually.	Film packet crossways. Holder No. 1 or No. 2. (Some prefer to place the packet longways).	Mesial edge of packet at center of Central Incisor, or farther mesially. (Make certain to get the Cuspid).	About 7 seconds	About 6 seconds	
Lower Molars	10 Below	Straight through between the First and Second Molars.	Film packet crossways. Holder No. 1 or No. 2.	Mesial edge of packet about the Distal of the Second Bicuspid. (Make certain to get the First Molar).	About 7 seconds	About 6 seconds	

The time given is for Buck X-Ograph or Eastman "Regular" (slow) films; figure ¼ to ⅓ as much time for Buck X-Ograph "Speed" or Eastman "Extra-Fast" films.

Instead of giving more time for the upper incisors and molars, the operator may, if he uses a Coolidge tube and has an autotransformer control, increase his penetration some.

It will be noticed that the time of exposure is given as *"about"* so-and-so. The reason for this is that the time of exposure cannot be figured with absolute mathematical precision. A certain milliampere-second exposure which is correct with one radiographic outfit may prove to be a little off with another outfit.

The general aim has been to overestimate the time of exposure rather than underestimate it, the latter being the common mistake in charts and printed directions.

* The vertical angles given here are, for the most part, *"safe"* angles, *not* the best angles, but they are so to speak the expedient angles for a set-of-ten negatives. The set-of-ten negatives does not represent a thorough X-ray examination of the mouth. It is, at best, only an X-ray *glance* at the mouth as distinct from an X-ray *scrutiny* such as may be made. In the effort to get all the teeth on 10 films some of the negatives are made at angles which are admittedly not right to make correct X-ray images of the parts.

Chart B.—Ten-Film Survey—Technic Chart. (From book "Radiodontia," by courtesy of Dental Items of Interest Publishing Co.)

Fig. 19.—The fourteen-negative whole mouth-survey. See "Technic Chart."

FOURTEEN-FILM SURVEY—TECHNIC CHART

FOURTEEN-FILM SURVEY—TECHNIC CHART

Teeth	*Vertical Angle*	*Horizontal Angle*	*Filmholder*	*Position of Film*	*Time of Exposure Factors* Film-Target Distance, 18 In. Milliamperage, 20 ma. Spark-Gap Back-Up, 4½ In. (57,000 Volts)	*Time of Exposure Factors* Film-Target Distance, 8 In. Milliamperage, 10 ma. Spark-Gap Back-Up, 3 In. (45,000 Volts)	*Time of Exposure Factors* Film-Target Distance ..... Milliamperage, Spark-Gap Back-Up ..... (To be filled in by individual operator).
Upper Central Incisors	40 Above	Straight through between Central Incisors	Use film packet longways. Holder No. 1 or 2—preferably No. 1.	Center of film packet between Central Incisors	About 8 seconds	About 7 seconds	
Upper Cuspid and Lateral Incisor	45 Above	Straight through Cuspid	Use film packet longways. Holder No. 1 or 2—preferably No. 1	Mesial (front) edge of packet at *about* center of Central Incisor, or a little farther mesially.	About 7 seconds	About 6 seconds	
Upper Bicuspids and First Molar	30 Above	Parallel with the Mesial surface of the First Molar	Film packet crossways. Holder No. 1 or 2—preferably No. 1	Mesial (front) edge of packet about mesial of Cuspid.	About 8 seconds	About 7 seconds	
Upper Molars (Particularly the second and third).	30 Above	Straight through between the Second and Third Molars	Film packet crossways. Holder No. 1 or No. 2—preferably No. 1	Mesial edge of packet *about* center of Second Biscuspid, or a little farther distally.	About 10 seconds	About 7½ or 8 seconds	
Lower Incisors	15 Below	Straight through between the Central Incisors	Film packet longways. Holder No. 3.	Center of film packet between Central Incisors.	About 7 seconds	About 6 seconds	
Lower Cuspid and First Bicuspid	20 Below	Straight through Cuspid	Film packet longways. Holder No. 3.	Mesial edge of packet between Central Incisors.	About 7 seconds	About 6 seconds	
Lower Second Bicuspid and First Molar	10 Below	Parallel with the Mesial surface of the First Molar	Film packet crossways. Holder No. 1 or No. 2	Mesial edge of packet about mesial or middle of First Bicuspid.	About 7 seconds	About 6 seconds	
Lower Molars (Particularly the Second and third).	5 Below	Straight through between the Second and Third Molars	Film packet crossways. Holder No. 1 or 2. (Sometimes holder No. 3 to get a view of the tissues distally and above the Third Molar).	Mesial edge of packet about mesial of the First Molar, or farther distally. (Make certain to go back far enough).	About 7 seconds	About 6 seconds	

The time given is for Buck X-Ograph or Eastman "Regular" (slow) films; figure ¼ to ⅓ as much time for Buck X-Ograph "Speed" or Eastman "Extra-Fast" films.

Instead of giving more time for the upper incisors and molars, the operator may, if he uses a Coolidge tube and has an autotransformer control, increase his penetration some.

It will be noticed that the time of exposure is given as *"about"* so-and-so. The reason for this is that the time of exposure cannot be figured with absolute mathematical precision. A certain milliampere-second exposure which is correct with one radiographic outfit, may prove to be a little off with another outfit.

The general aim has been to overestimate the time of exposure rather than underestimate it, the latter being the common mistake in charts and printed directions.

Chart C.—Fourteen-Film Survey—Technic Chart. (From book "Radiodontia," by courtesy of Dental Items of Interest Publishing Co.)

THE TECHNIC OF ORAL RADIOGRAPHY

By Dr. Clarence O. Simpson, St. Louis, Mo.

REGIONS IN DETAIL (Continued)

Maxillary First Molar Region

(*Continued from page 559.*)

Position of Head. Occlusal plane of maxillary teeth horizontal.

Vertico-horizontal Angle of Projection. Average 32 degrees.

Modifications. Thirty-five degrees or more where there is a marked buccal inclination of the teeth, or the roots are unusually long. Thirty degrees or less as the teeth approach a vertical position, or the roots are exceptionally short.

Mesio-distal Angle of Projection. Parallel with the mesial surface of the first molar.

Modifications. Compensation for a marked rotation of the first molar, or to avoid the malar process.

Placement of Film Packet. Longer dimension horizontally. Upper mesial corner slightly bent. Place packet to include the first premolar, and extend distally to the length of the packet; occlusally to include the cusps of the teeth in symmetrical relation to the side of the packet at the predetermined angle of projection.

Retention of Packet. Thumb of patient's opposite hand placed slightly nearer the upper mesial corner.

Spark Gap. 4 to 4½ inches.

Exposure. 110 to 150 milliampere seconds at an 18 inch target-film distance.

Explanatory Description. The principal difficulties encountered in the examination of the maxillary first molar region are the proximity of the malar process, and the complications from the three divergent roots of the first molar. The premolars are included in this region because the angle of projection for a lingo-buccal view of them approximates that of the first molar. Although the second and third molar is disregarded in this view, supplemental information on the region is often obtained. The three molars cannot be included to advantage in examination because of the variance in direction of the bucco-lingual axes, and the obstruction of the malar process and malar bone.

In calculating the vertico-horizontal angle of projection, a compromise between an accurate image of the buccal roots and the lingual root of the first molar must be accepted since the roots lie in different planes. The desirable mean angle will record the approximate root length of the premolars, foreshorten the image of the buccal roots of the first molar, and

elongate the image of the lingual root. Where extreme divergence of the roots occurs, separate views may be required for the buccal roots and the lingual root.

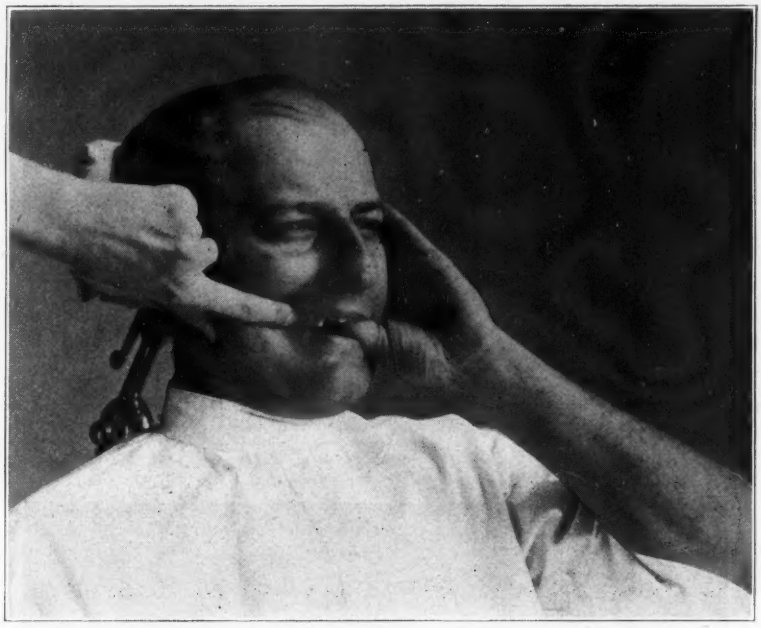


Fig. 1.—Position of film packet and retaining hand for the maxillary first molar region.

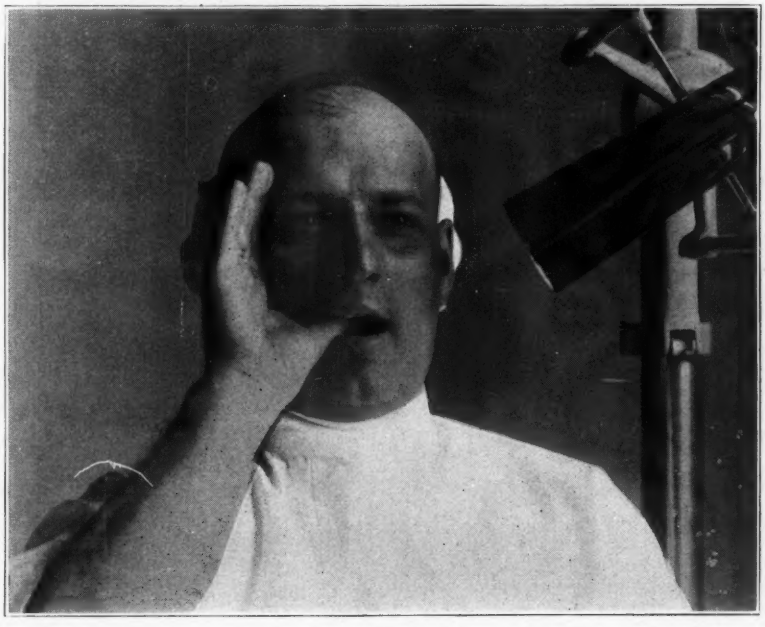


Fig. 2.—Position of patient and cone for the maxillary first molar region.

The mesio-distal angle recommended for the first molar region discloses proximal caries, and inter-proximal conditions from the distal surface of the canine to the mesial surface of the second molar. It projects the roots of the first molar symmetrically grouped with the mesio-buccal superimposed,

but the apices of the lingual and disto-buccal roots unobstructed. The mesio-buccal root is usually projected for a more favorable view in the examination of the second and third molar region. Caution must be exercised in

Fig. 3.—Typical views of the maxillary first molar region disclosing the apices of disto-buccal and lingual roots by the mesio-distal angle of projection, paralleling the mesial surface.

Fig. 4.—An illustration of the malar process obscuring the lingual root of the first molar at the usual mesio-distal angle, and the distortion of the buccal roots in revealing the lingual root.

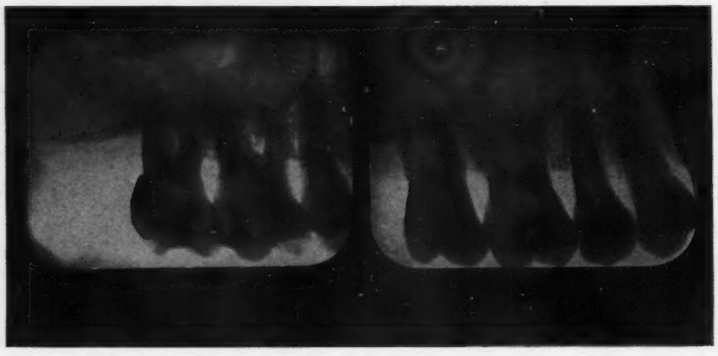


Fig. 5.—Illustrating the projection of the mesio-buccal root of the first molar for view in examination of the second and third molar region, while the disto-buccal and lingual roots are disclosed in the first molar examination.

determining conditions around the buccal roots of the first molar when they are projected beyond the superimposed portion, as the greater radiolucence of the structures are likely to be misleading.

In a considerable proportion of subjects the malar process obstructs the most desirable view of the first molar, and it is necessary to project the lingual root separately by directing the rays more nearly parallel to a line from the mesio-buccal angle to the disto-lingual angle. This distorts the image of the buccal roots which require another view at the usual mesio-

Fig. 6.—Illustrations of unfavorable views at the normal angle of projection because of marked root divergence.

Fig. 7.—Illustrating the radiolucence around the buccal roots of the first molar when they are projected beyond the lingual root.

buccal angle but a vertico-horizontal angle of about 10 degrees less than that for the lingual root. The great variation in the relation of the first molar roots, often require further examination of the region after the negative produced at the normal angle of projection has been examined. If the angle for each exposure is closely observed, the corrections to give additional information can be accurately made.

(*To be continued.*)

ABSTRACT OF CURRENT LITERATURE

Covering Such Subjects as

ORTHODONTIA — ORAL SURGERY — SURGICAL ORTHODONTIA — DENTAL RADIOGRAPHY

It is the purpose of this JOURNAL to review so far as possible the most important literature as it appears in English and Foreign periodicals and to present it in abstract form. Authors are requested to send abstracts or reprints of their papers to the publishers.

The Occurrence and Prevalence of Mottled Enamel. C. D. Woodford (Plainview, Tex.). The Journal of the American Dental Association, February, 1923, x, 2.

This peculiar endemic affection of the teeth which is encountered in very different parts of the world in limited areas is new in literature only, for its existence has been known for many years. It is encountered in some of the Southern and Pacific Slope states, in the Bahamas, Cape Verde Islands, Holland, Italy, etc. The discoloration is brown or black and mottled as the name states. In localities where it is endemic it may affect nearly all of the native born children, at least to 90 per cent. Apparently it is limited save with rare exceptions to the permanent teeth. Certainly it cannot be looked on as congenital. Descriptions show more or less disparity and it is by no means certain that the same affection is always present. Where there is a mixed population the disease shows no favoritism, all races being attacked alike. In some localities the artesian well water has apparently been found guilty of being the essential causal factor, but in other countries this factor is absent for only surface water is drunk. It may be shown experimentally that during the formative period of the enamel the latter can stain *in vivo* with certain coloring matters injected into the blood, as trypan blue. From this angle the affection may be regarded as an example of vital staining. In some localities the incidence is less than in others and as few as 35 per cent may show the mottling. This immunity is difficult to understand if the drinking water is a causal factor. It seems certain that the mottling never attacks fully developed enamel.

Why Do More Men Leave the Dental Profession Yearly Than Enter It? W. O. Talbot (Fort Worth). The Texas Dental Journal, March, 1923, xli, 3.

This fact was brought out by T. B. Hartzell in his presidential address (National Dental Association) last July. In 1921 the number to enter the profession had been 1432 while the number to abandon it had been much

greater—1900. But before that it had been pretty well understood that one dentist in every three drops out of his profession sooner at later, or more accurately within the first ten years. There must be some good reason or reasons for this abandonment, but as no data have thus far been adduced in explanation the reasons must for the present be conjectural. The author regards the problem as one of finance chiefly. The expense of the education, equipment and "starvation" years of the beginner place him heavily in debt. The average age at graduation has become progressively greater and is now said to be 27 years. To this must be added several years of waiting and running in debt. It is clear from the economic standpoint that the dentist should be permitted to practice his profession at a much earlier period and attempts have been made to go to the other extreme and license any young man of 19 who can pass the state boards. Doubtless the optimum age should be midway between these extremes or around the age of 23. At the age of 26 or 27 the dentist could then be self-supporting and his indebtedness would be much less formidable. The dentist, unlike some other professional men, is poorly situated for working his way through his undergraduate years. Next to financial reasons the hard character of the work is a cause for change of occupation, many being physically unable to work continuously in the standing position at such a nerve racking occupation. The barber who stands in the same manner for long hours is under far less nerve strain, or at least that is what he says when asked why his work is not more fatiguing.

Demonstration of Prophylaxis of Dental Caries. R. L. Spencer Bennetsville, S. C.). The Dental Summary, March, 1923, xliii, 3.

In his twenty-two years of practice the author has noted that between the ages of 6 and 12 years the average child develops from 3 to 6 cavities annually. In a considerable material of children, say fifty individuals, the total number of cavities to develop in any given year may therefore be foretold with considerable accuracy. The author formed a class of 46 children who showed collectively at the beginning of the scholastic year 164 cavities in permanent teeth, all of which had been filled. During the ensuing year under the author's prophylaxis efforts but 8 cavities developed in the entire class, equivalent to a reduction of 95 per cent. Moreover the eight cavities occurred in 6 children, the other forty having a perfect score. Of the eight cavities six could be traced to want of obedience on the part of four children.

The prophylactic measures were simple and natural. At the outset, the teeth were cleaned and of course as stated all cavities had been filled. Teeth were cleaned by the patients after each meal including the gum tissue, using the pick, brush and floss silk. Each child reported at monthly intervals and on each occasion the teeth were examined and polished.

The author has in a similar manner shown in adult subjects that pyorrhea alveolaris may be prevented.

The success of the author in the caries episode was evidently due in great part to the close touch and control which he was able to exert over his

patients. The class was originally composed of 50 children but 4 of these dropped out. It was possible to keep in touch with the mothers by telephone and letter, which fact appears to indicate that the social status of the class was above the average. In cases in which there was a likelihood of defective home training the child was taught directly as to dental hygiene.

Collapse From Novocain Anesthesia. A Kneucker (Vienna). Zeitschrift für Stomatologie, March, 1923, xxi, 3.

The author having recommended 4 per cent novocain infiltration anesthesia, Dr. Chaim, who used it in this strength, reported a case of severe collapse. He states that if 2 per cent novocain does not answer he would not use the drug in higher concentration, but would give gas or eusemin. The author replies that eusemin is a cocain preparation and more toxic than novocain, while narcosis has its own indications. It is admitted that ½ per cent solutions of novocain often act well and that next in the scale is the 1 per cent solution, after which comes the 2 per cent. The 4 per cent novocain-adrenalin is the next logical concentration to use, but only under certain conditions which the author has carefully laid down in past years. Since he began to advocate its use it has become a fixture in some of the leading clinics of Europe. In regard to collapse the author states that this may be seen at times with the 2 per cent solution, and in all such cases every effort should be made to fathom the essential factors. These would include the adrenaline used, the technic of injection and so on. In a collapse with 2 per cent solution it was proved that no anesthetic had been absorbed at all, the causes being apparently psychic and such as could not have been foreseen or prevented. In this case death seemed imminent and recovery took place only after injection of alcohol, camphor, etc., heart massage and artificial respiration. In such cases there may be a serious cardiac lesion or some nervous defect, lack of sleep or nutriment and so on. The state of the barometer may be unfavorable or the odors of the dentist's office may have a depressive effect on the psyche. As in the case cited above collapse may occur without any reference to the anesthetic. In one case a man died after extraction but the dentist had forborne to use an anesthetic on account of the looseness of the tooth in its socket. The patient was found to have nephritis. A woman collapsed once after a 2 per cent extraction, but her death a few days later showed a pelvic abscess which had broken and caused peritonitis.

Diet, Dental Structure and Caries. Mellanby and others (discussion). The Dental Record, May, 1923, xliii, 5.

At the recent session of the Royal Odontological Society, Mrs. Mellanby gave some of the results of her latest studies. After the teeth had erupted they produced secondary or adventitious dentine, which is a factor in the defense against caries. She had already shown that vitamine A is of value in the development of the teeth and jaws and that it aids in the resistance to infection; these truths may readily be brought out by feeding experiments

with animals. But this vitamine is not the sole factor, for there are a number of separate growth factors, neglect of any one of which may unfavorably influence development and resistance.

A series of examinations of deciduous teeth in man showed that hypoplastic development was an important factor in caries. Moreover carious teeth which seemed perfectly well developed were found to be defective in secondary dentine, while another factor favoring caries was filling of the pulp with cementum. Very rapid development of caries, however, gives secondary dentine no chance to develop. This substance appears when there is attrition or caries, and if it forms too rapidly its conservative action is not exerted. The same diet which favors the development of sound teeth also favors the development of resistance to infection.

Mummery objected that some teeth of poor structure never developed caries. There must be some other factor active—perhaps the enamel. Broderick suggested that the unknown factor might be endocrine in nature. Endocrine derangement might be due to very different causes. Pitts, in a research on deciduous teeth, found but a small percentage with hypoplasia and is at a loss to understand the 84 per cent of Mrs. Mellanby. He states that the secondary dentine of attrition is of better quality than that laid down in response to caries. He doubted the influence of diet on secondary dentine.

Elongation of Teeth From Absence of Antagonists. Gottlieb (Vienna). Zeitschrift für Stomatologie, April, 1923, xxi, 4.

The author introduces this subject in a long article on diffuse atrophy of the alveolar process. Some years ago Loos claimed that in the fundus of the alveolus of the elongated teeth there were evidences both of production and defect. At the tips of the roots he found hyperplasia of the cement in a state of active proliferation. This process is the result of failure of counter-pressure. In other words there is latent energy of growth in the bone. As chewing pressure is absent it is possible to apply artificial counter-pressure. This constant pressure is able to destroy the floor of the alveolus and open a communication with the marrow cavity. The periodontal space is widened and there is a new deposit of bone.

When chewing pressure no longer exists the teeth may fall out one by one—this happens if the vitality is low—or there is a reaction in the surface of the root. The periodontal space is broadened and there is formation of new cementum. At the same time new bone is formed in the alveolus with ligamentous attachment to the root surface. Thus according to Loos we see in these cases preservation of vitality associated with loss of function. In the diffuse atrophy of the alveolus in pyorrhea we see the converse—loss of vitality is associated with retention of function.

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EDITORIALS

The Overtrained Dental Assistant

THE *New York Medical Weekly,* of May 5, contained an article entitled "The Overtrained Nurse." The facts presented in this editorial parallel the situation as we find it in dentistry today to such an extent that we feel it would be of an advantage to the dental profession to quote certain portions of the editorial. The problems which are outlined in this article are the same as exist in the practice of dentistry.

"To the practicing physician the training of his nursing aides has become an increasingly serious problem of recent years. The trend away from practical experience and towards elaborate theoretical training, instead of resulting in a better and more efficient type of nurse, as its advocates had

hoped, has developed an anomalous theorist who is neither doctor nor nurse and yet, in many cases, feels herself equal to the prerogatives of both."

This outlines exactly the situation that is arising in the dental profession as a result of the education of dental hygienists and dental assistants. In our orthodontia clinic we often have referred to us, children from schools and institutions that have had the service of dental hygienists. In several instances we have been informed that the dental hygienist has outlined a proposed treatment for the malocclusion and informed the patients that only such treatment as she has outlined was indicated. In most of these cases we find the diagnosis has been faulty in the beginning. The dental hygienist, who is neither a dentist nor an orthodontist, has placed her opinion above those of the experienced practitioner.

Several years ago, our friend Dr. Barrett called attention to the fact that the dental hygienist as she was being educated in certain localities was neither a nurse, an assistant, nor a dentist. She is the result of ideas originating from the minds of certain individuals; the outcome of certain theories which as yet have not been proved, and the application of the principles today tend to show that the whole thing is unsatisfactory. However, different institutions are going ahead and creating dental hygienists and dental assistants the same as certain schools and hospitals are producing nurses. All these groups seem to have forgotten that their prime motive is caring for the patient. The matter is made worse when some of these impractical ideas are advocated by institutions which have set a certain standard for education. *The Medical Weekly* states: "Now Yale University, with the financial aid of the Rockefeller Foundation, announces that it will establish an undergraduate school of nursing with a course that will eliminate the unpleasant routine tasks of the apprenticeship plan hitherto in operation (and dependent upon medical schools and colleges) and will give instead a theoretical education in the factors contributing towards diagnosis, care and treatment of disease. Superficially, this may seem a very laudable proposition, designed to give the public the type of nurse it needs. To us it seems that the real function of the nurse is being overlooked in agitation.
* * *

"With every respect and appreciation of the intelligence, of devotion, and the self-abnegation of the nursing profession the fact remains that the nurse is the assistant of the doctor, whose chief function it is to carry out his orders intelligently and conscientiously and make the patient as comfortable and as happy as possible. * * * Much of the theory now taught in training schools is unnecessary—and even dangerous in the assumption of medical knowledge it creates within the nurse. * * *

"The Yale plan is radically wrong. If persisted in along the proposed lines, not only will it fail to alleviate the existing shortage of nurses, but it will, by so-called 'higher training,' deprive the sick-room almost entirely of the type of woman who is the doctor's chief aide."

The position which the medical profession faces is similar to that in which the dental profession finds itself today. It is a well-known fact that

the most efficient dentist's assistant is the one who is trained in the way of the man for whom she works. Many have employed dental hygienists, trained dental assistants, only to find such women believe their purpose is to run the office and regulate the practice of the dentist. In other words, many of them seem to believe the dentist has established his office simply as a place for them to show their authority and put into practice the theories that have been taught them that are not in keeping with the practice of the dentist. They believe the purpose of the dentist is to obey the orders of the trained assistant and each week pay them their salary. The overtrained dental assistant is just as obnoxious as the overtrained nurse and we hope conditions will soon adjust themselves whereby dental assistants will be made to realize that their function is to assist and not to execute.

Dental State Board Questions and Answers*

THE third edition of Goepp's State Board Questions and Answers follows very much the same line as the previous editions. The subject matter is quite complete, beginning with the consideration of physics and electricity. Chemistry is considered from a standpoint of inorganic and physiologic chemistry. There are also a number of questions devoted to metallurgy. Forty-four pages are devoted to anatomy and embryology. Physiology is also very completely treated as is pathology, bacteriology, hygiene and surgery. Orthodontia receives consideration in nine pages. Probably these questions have been copied from the State Board Questions in the past but they are very antiquated compared to modern orthodontics. Some of the questions more correctly belong to prosthetics. We find reference to appliances which are obsolete so far as modern orthodontics is concerned. They still believe the "Cuspids" and "Bicuspids" are part of the teeth of man. However, the book will fulfil the demand for answers to some of the questions encountered in State Board examinations.

We know of no book which quite takes the place of Goepp's Questions and Answers. We realize the author in compiling such a work renders a service to the graduating students that can only be appreciated by one who has had to prepare for State Board examinations. As a book intended for a certain purpose, we believe it has filled that ideal.

*The Dental State Board Questions and Answers, By R. Max Goepp, M.D., 3 ed. Revised. Published by W. B. Saunders Co., Philadelphia, Pa.

ORTHODONTIC NEWS AND NOTES

The American Dental Association

The American Dental Association will meet in Cleveland, Ohio, September 10 to 14. The following is the program for the Orthodontia Section:

(Ballroom, Statler Hotel. All subsequent *ORTHODONTIA AND PERIODONTIA* meetings held in same place.)

OFFICERS OF SECTION

Clyde M. Gearhart, Chairman, Washington D. C.
William C. Fisher, Vice-Chairman, New York, N. Y.
B. Frank Gray, Secretary, San Francisco, Cal.

Tuesday Afternoon, September 11
2 P. M. to 5 P. M.

"The Alimentary Tract, a Talk to Dental Patients." By Gillette Hayden, Columbus, Ohio.

Synopsis—The mouth the first of three reservoirs. Its strategic position as the port of entry; its service to the whole body; its share in the choice of foods and in their preparation for the second reservoir, the stomach. The journey of the body's fuel from the second to the third reservoir or colon. Some of the effects of an imperfectly used or a crippled dental apparatus upon the other parts of the alimentary tract.

Discussed by
Celia Rich, Nashville. Tenn.
E. Melville Quinby, Boston, Mass.

"Clinical Evidence, with a Working Hypothesis, Favoring Pulp Extirpation in Children's Teeth." By Norris C. Leonard, Baltimore, Md.

Synopsis—For orthodontic reasons, alone, continued healthy functioning of the deciduous teeth, and the preservation of the permanent ones erupted during the developmental period of the jaws is of immense importance. A simple method is presented for consideration of both the general practitioner and the orthodontist for treatment of pulp exposures, favoring the physiological shedding of the deciduous teeth, and continued development of the incompletely calcified roots of the permanent ones.

Discussed by
U. G. Rickert, Ann Arbor, Mich.
Harry E. Kelsey, Baltimore, Md.

"The Varied Reactions to Injury from Traumatic Occlusion." By Paul R. Stillmann, New York, N. Y.

Synopsis—The paper discusses and differentiates between stimulation and irritation. The phenomenon of irritation being the fundamental factor in the etiology of inflammation, viz., "a reaction to injury." Disease of the peridontium and allied structures is described as an inflammation. Several very unusual being selected with the intention of showing "the varied reactions to injury from traumatic occlusion." This relation of the teeth is identified as a mechanical injurious agent whose influence is at times a stimulant and induces inflammation according to the degree of resistance to attack. The subject is also discussed as to whether traumatic occlusion occurs as a result of migration due to inflammation or if it is a constant factor in those cases having it, and is thereby of itself the cause of disease.

The relation of traumatic occlusion as it has been observed when induced by the migration of teeth through orthodontic treatment is discussed. A distressing case illustrating such an instance is described. Slides of clinical cases will be shown.

Discussed by
Frank M. Casto, Cleveland, Ohio.
Olin B. Kirkland, Montgomery, Ala.

Wednesday Morning, September 12
9 A. M. to 12 M.

"The Nomenclature of Periodontology." By John Oppie McCall, Buffalo, N. Y.

Synopsis—Periodontology is a branch of dentistry whose development has been very rapid in the past ten years. With increasing knowledge there has come the need for a terminology adequate to express this knowledge. The terms presented in this paper are largely those which have been adopted by the American Academy of Periodontology. Many of these are in use in the dental literature of today. But it has been thought advisable to present a somewhat extended discussion of these words, to make clear their correct usage, and to give opportunity for debate as to their suitability.

Discussed by
R. Ottolengui, New York, N. Y.
L. Pierce Anthony, Philadelphia, Pa.

"Bridgework from a Periodontist's Standpoint." By Andrew J. McDonagh, Toronto, Canada.

Synopsis—The effect of artificial substitutes for teeth which have been lost as far as the investing tissues of the other teeth are concerned. The reasons given for the injurious torque. How torque acts on the investing tissues of the natural teeth; why pocket formation takes place; why so-called recession of the gingival tissues takes place; why one kind of artificial restoration has less injurious effect on the periodontal tissues than another kind. How fixed bridgework compares with removable bridgework in this connection and the best method, from the standpoint of preservation of the periodontal tissues. The best method of replacement from the standpoint of periodontal tissues.

Discussed by
Arthur H. Merritt, New York, N. Y.
Justin D. Towner, Memphis, Tenn.

To the memory of Calvin S. Case, who, life permitting, would have occupied this hour with a valuable presentation on "The Early Regulation of Children's Teeth."

"Calvin S. Case. The Teacher"—John P. Buckley.
"Calvin S. Case, The Author"—Otto U. King.
"Calvin S. Case, The Practitioner and Scientist"—Hart J. Goslee.
"Calvin S. Case, The Man" C. N. Johnson.
"Calvin S. Case, The Orthodontist and Friend"—Thos. L. Grisamore.

Wednesday Afternoon, September 12
2 P. M. to 5 P. M.

(Wednesday afternoon to be devoted to program of Detroit Clinic Club.)

Thursday Morning, September 13
9 A. M. to 12 M.

"Orthodontic Eruption of Impacted Cuspids and Incisors." By Varney E. Barnes, Cleveland, Ohio.

Synopsis—1. Expand to provide *extra space* for impacted tooth. 2. Fit removable retainer as anchorage. Add springs and hooks to hold surgical packing. 3. Surgical exposure of impacted tooth. 4. Fit packing of paraffin saturated spunk over tooth to fill wound. Attach to retainer. Cover packing with antiseptic powder and lock appliance in place. 5. Apply antiseptic and replace frequently until wound heals, exposing tooth. 6. Band tooth if possible, or drill pit for special locked inlay, carrying loop or hook. 7. Erupt tooth with orthodontic pressure.

Discussed by
Herbert A. Pullen, Buffalo, N. Y.
Burt Abell, Toledo, Ohio.

"Endocrine Activity as Applied to Orthodontic Types of Unknown Origin." By C. C. Howard, Atlanta, Ga.

Synopsis—A general consideration of bony development viewed from the standpoint of ductless gland disorders. Association of dental arch and jaw mal-formation is studied in the correlation of such disturbances. An attempt is made to definitely connect these phenomena, considering the possibility of linking together an imbalance of the glandular system with improper arch progress.

Discussed by
Albert W. Crosby, New Haven, Conn.
Joseph D. Eby, New York, N. Y.

American Society of Dental Radiographers

The third annual meeting of the American Society of Dental Radiographers will be held in Cleveland, Ohio, September 7-8, 1923. The following program will be carried out:

Friday, September 7th

10:00 "The Relation of the Radiographer to the Patient as Well as the Practitioner." By Dr. L. R. Main, St. Louis, Mo.
11:00 "The Advantage of Rigid Films of Various Sizes in Radiographing the Mouth." By Dr. J. A. Blue, Birmingham, Ala.
12:00 "The Responsibility of the Radiographer Regarding Interpretations." By Dr. F. W. Prosseus, Rochester, N. Y.
3:00 "The Importance of Radiography in Referred Cases from the Medical Standpoint." By Dr. J. A. Bliss, Sioux City, Iowa.
4:00 "The Dental Roentgenologist." By Dr. S. M. Getzoff, New York City, N. Y.

Saturday, September 8

9:30 Business Session, Reading of minutes Raper, Indianapolis, Ind.
11:00 Election and Installation of Officers.
10:00 "Technic Only." By Dr. Howard R. of previous session.